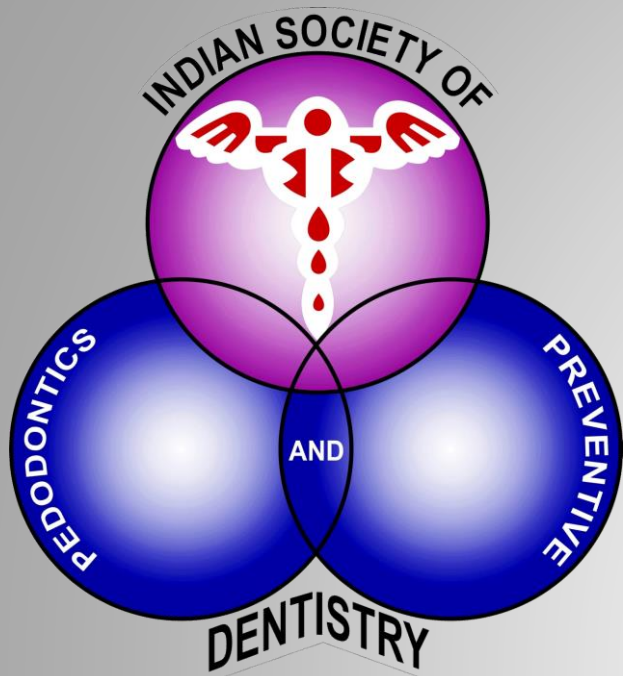


DR. SHIVAYOGI M.HUGAR



- Is a graduate and post graduate from prestigious KLE Society's VK Institute of Dental Sciences, Belagavi, Karnataka.
- He has completed Research Methodology course from ICMR.
- He is a postgraduate & PhD guide with 14 years of teaching experience.
- Has been honoured as Life member of prestigious KLE Society.
- Having total 95 publications in both international & national journals.
- He is having 7 patents from Indian Patent Office.
- Has designed special brush and Oral Health Care book for visually impaired children in Braille.
- Presented scientific presentations in National and International conferences.
- Received research grants from ICMR.
- Received Best NSS officer award.
- Has served as Chairperson of Board of Studies for clinical subjects of KLE University.
- Presently working as Professor and Head, Dept of Paediatric and Preventive Dentistry, KAHAR's KLE VK Institute of Dental Sciences, Belagavi.
- Speaking on
“Pulp Dentine Complex and Diagnosis of Diseases of the Pulp”



PULP-DENTIN COMPLEX

&

DIAGNOSIS OF DISEASES OF THE PULP

Dr. Shivayogi M. Hugar

Prof. and Head

Department of Pediatric and Preventive Dentistry

KAHER's KLE V.K. Institute of Dental Sciences

Belagavi, Karnataka, India

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LIFE ISNT JUST ABOUT DARKNESS OR LIGHT, RATHER IT'S ABOUT FINDING THE
LIGHT WITHIN THE DARKNESS



QUESTIONS

ANSWERS

What questions are most commonly asked???

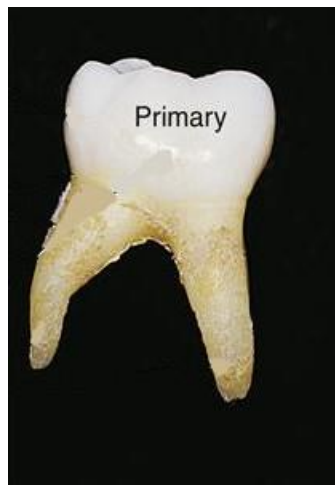
1. Explain the structure of pulp and its functions
2. Add a note on the morphological and histological difference between the primary and permanent teeth
3. Detail about Pulp-Dentin complex. **“Dental pulp is still the black box”**.
4. Describe the significance of various chair side tests used to determine the status of pulp and also mention the reliability and validity of each test
5. Diagnosis of pulp diseases and their treatment in Pediatric Endodontics

What questions are most commonly asked???

6. Discuss various concepts of pain perception. How is perception of pulpitis pain brought about?
7. Discuss management of acute pulpitis in primary mandibular molars
8. Discuss the reaction of pulp to the various pulp capping materials**. Add a note on calcium hydroxide
9. Discuss the decision of performing pulpotomy with relation to accuracy in diagnosis and prognosis.

Differences between Primary and Permanent teeth

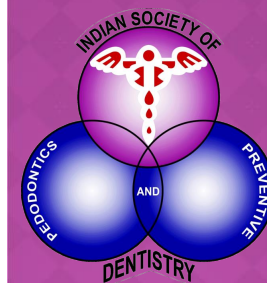
Characteristics	Primary Teeth	Permanent Teeth
Enamel	Thinner (~1mm)	Thicker
Dentin thickness between enamel and pulp chamber	Less	More
Reparative dentine	Extensive	Less Extensive
Nerve fibers	At odontoblastic zone	Extended till DEJ
Density of innervation	Less	More



Differences between Primary and Permanent teeth

Characteristics	Primary Teeth	Permanent Teeth
Pulp chamber	Comparatively larger	Comparatively smaller
Pulp horns	Higher	Lower
Pulp Floor	Porous and more accessory canals	Intact
Accessory canals	More	Less
Roots	Longer and slender ,flared and diverging	Shorter and bulbous; straight
Root canals	Ribbon shaped, The radicular pulp follows a thin, tortuous and branching path	Root canals are well defined and less branched
Furcation	Cervical area so less cervical trunk	Apical, thus the root trunk is larger
Vascularity and Cellularity	High	Less
Localization of Infection	Poor	Good

Camp JH. Pediatric Endodontic Treatment. Cohen S, Burns R. Cohen's pathways of the pulp. Elsevier Health Sciences; St. Louis, Missouri :Mosby, Inc. 2015. p 719-720.

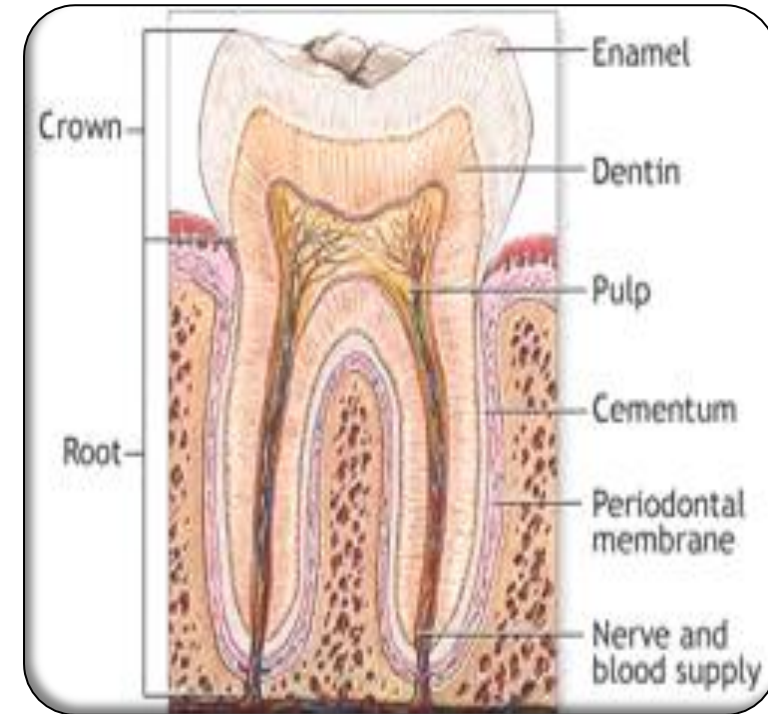


STRUCTURE OF TOOTH & PULP


PULP is a soft tissue of mesenchymal origin residing within the pulp chamber and root canals of tooth lined by a layer of highly specialized cells called the odontoblastic cells.

- Cohen

- The pulp – rich vascular connective tissue contained within a rigid dentinal wall



Why Pulp is special??



A low compliance environment.

Resilience of the
connective
tissue.

An ineffective
collateral
circulation.

Perceives all
types of stimuli
as **Pain**.



FUNCTIONS OF THE PULP

- Inductive

- Formative

- Nutritive

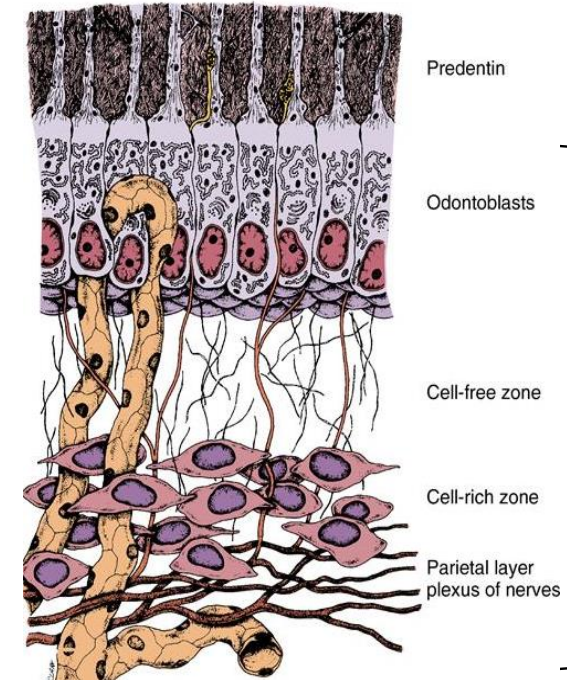
- Protective

- Defensive or reparative



PULP-DENTIN COMPLEX

- The **intimate relationship** between the odontoblasts, the cells present at the **pulp** interface which are responsible for dentin formation and the **dentin** can be referred to as *Pulp-Dentin Complex*
- **PULP DENTIN COMPLEX** is neither static or non compliant but it is **dynamic** & adaptive to environment stress.



Pulp-
dentin
complex

DIFFERENT LAYERS AND CONSTITUENTS

Odontoblast layer

- Odontoblast cells bodies, Capillaries, unmyelinated sensory nerve fibers,

Cell free zone of Weil

- Plexus of Raschkow (unmyelinated nerve fibres), capillaries, some fibroblast and ground substance.

Cell Rich Zone

- Fibroblast, undifferentiated mesenchymal cells, ground substance, macrophages, lymphocytes and plasma cells

Pulp Proper or Central Pulp

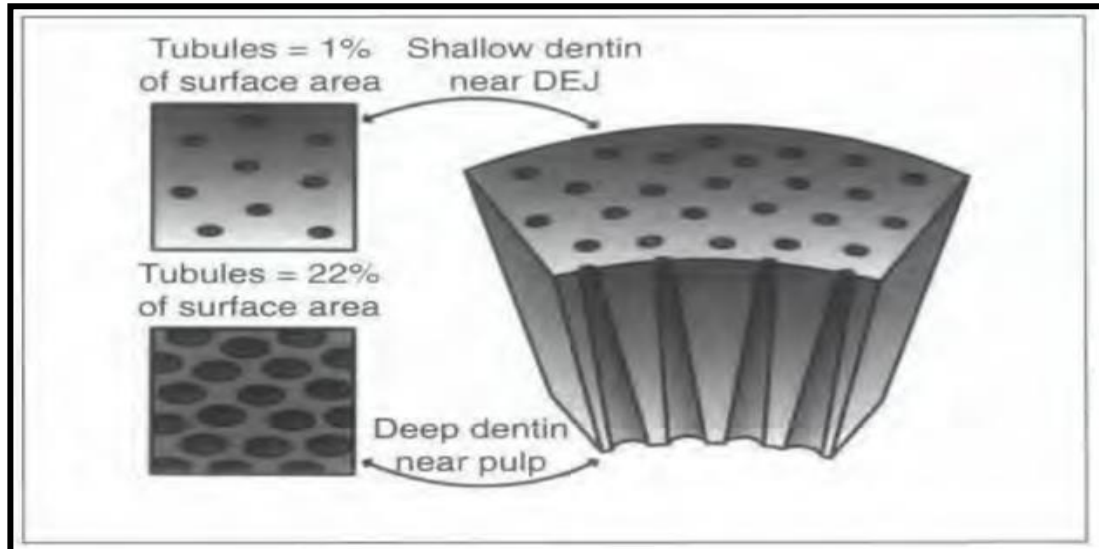
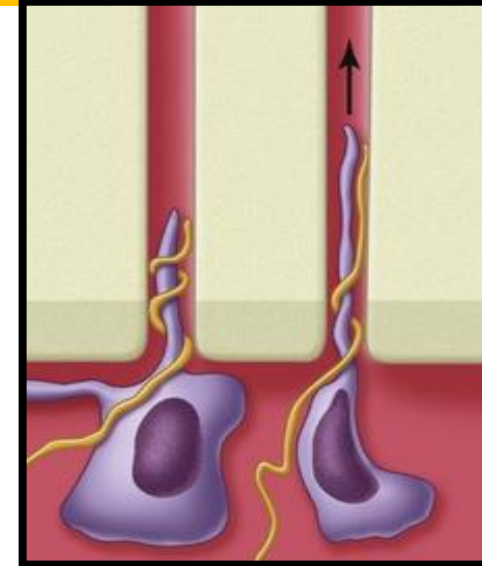
- Blood vessels, lymphatic vessels, Nerve fibers,

ODONTOBLASTIC ZONE

Odontoblasts are specialized cells and cell bodies form the odontoblastic zone in the pulp and cell processes within the predentin and dentinal tubules, extending into the dentine.

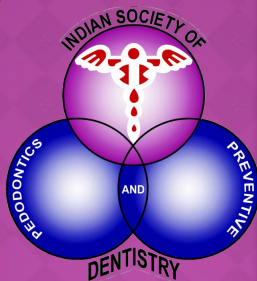
Odontoblastic processes extended 0.7mm into dentin or upto DEJ in perm teeth and end in predentin in primary teeth.

Dentinal tubules are “S” shaped in perm teeth and straight in primary teeth.



Choudhary N, Subba Reddy VV. Dentin comparison in primary and permanent molars under transmitted and polarised microscopy. J Ind Soc Pedo and Prev Dent. 2010;28(3):167-71.

- 1. **Odontoblasts** - approx. 45,000 per sq.mm in pulpal side & 20,000 sq.mm in dentin near enamel.
- 2. **Dentinal tubules** at DEJ – 1 μ ; Near pulp – 3 μ
- 3. **Cell and tubule density** is much less denser and crowded in the children as compared to adults.





Primary dentin

Mantle dentin

Circumpulpal dentin

Infected dentin

Affected dentin

Reparative dentin

Predentin

Globular dentin

Secondary dentin

Tubular dentin

Reactionary dentin

Tertiarty dentin

TYPES OF DENTIN

Pre-dentin

Primary Dentin
Before tooth eruption

Secondary Dentin
After tooth eruption

Tertiary Dentin
to noxious stimuli

Mantle Dentin

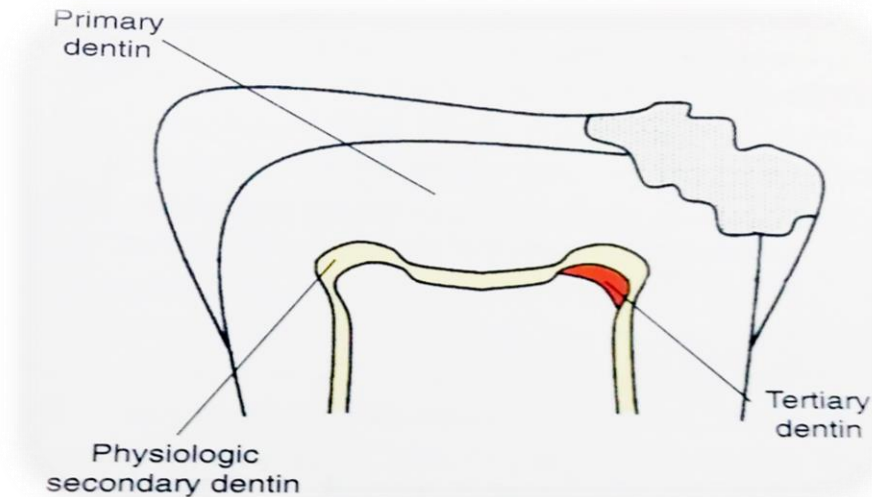
Circumpulpal Dentin

Intertubular Dentin

Peritubular Dentin

Reparative Dentin

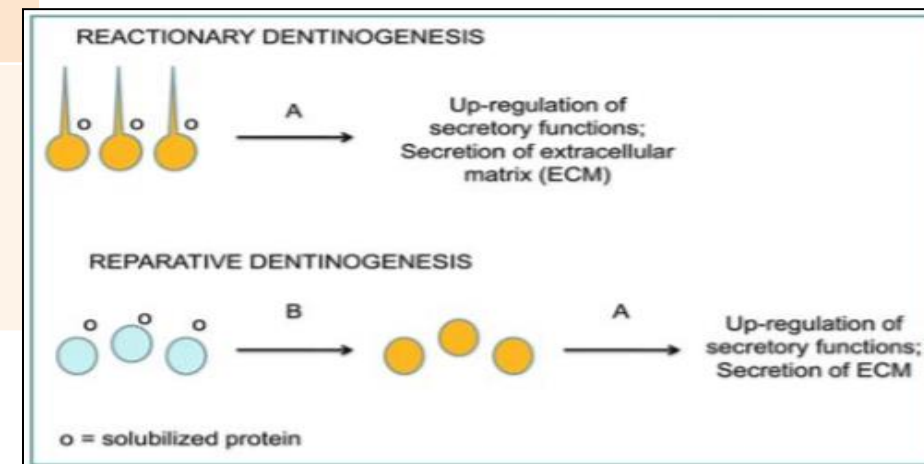
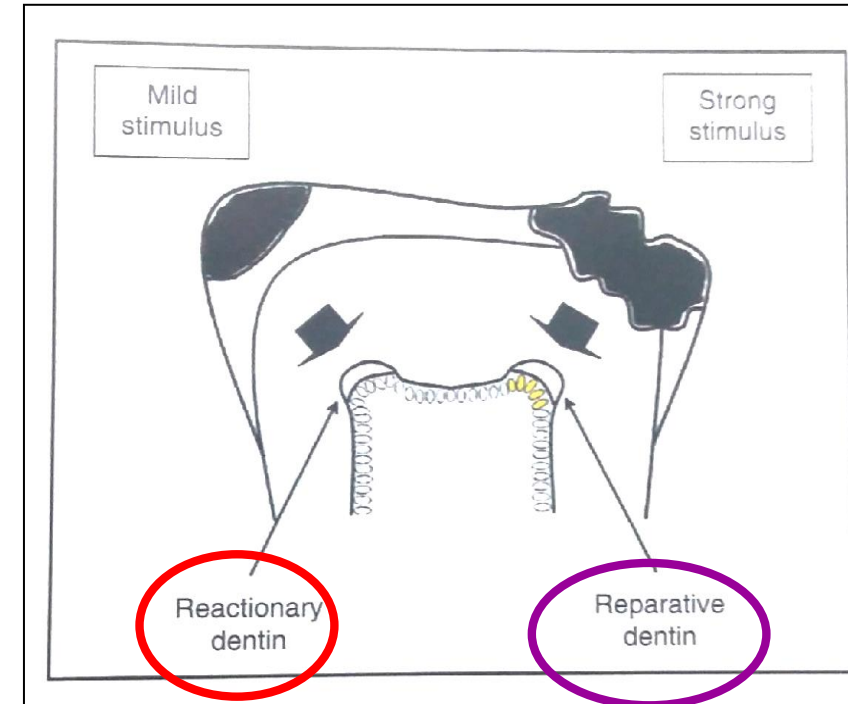
Reactionary Dentin



What is Calci traumatic line???

REACTIONARY AND REPARATIVE DENTIN

	REACTIONARY DENTIN	REPARATIVE DENTIN
Stimulus	Stimulus is mild	Noxious stimulus is aggressive
Formative Cells	Surviving post mitotic odontoblasts	New odontoblast-like cells from progenitors
Structure	Regular	Irregular
Procedure	Indirect pulp capping/ Remineralizing dentinogenesis	Direct pulp capping /Dentinogenic pulp capping

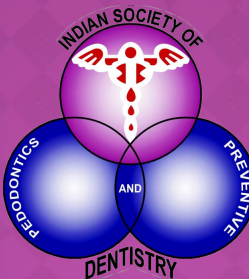
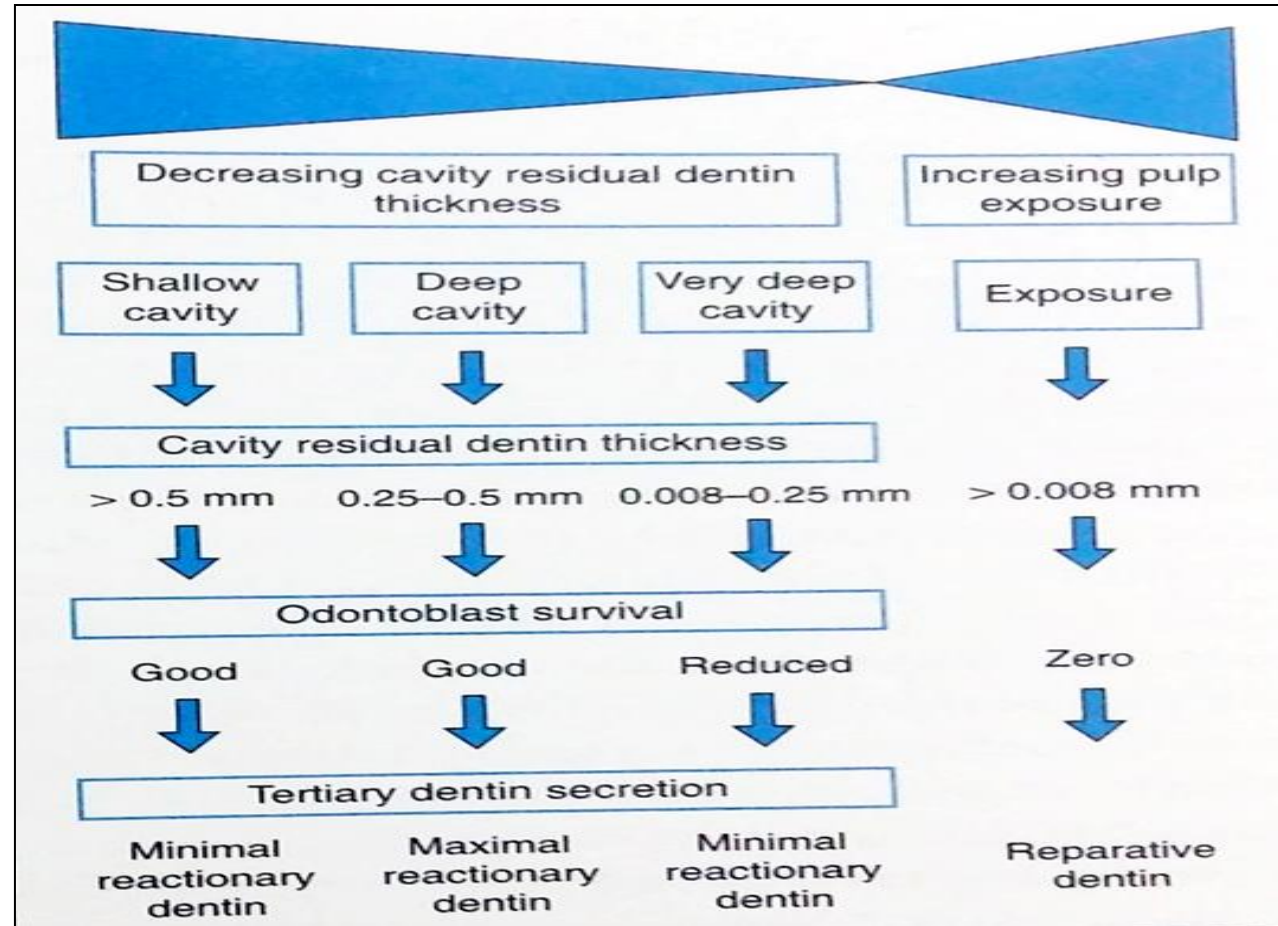


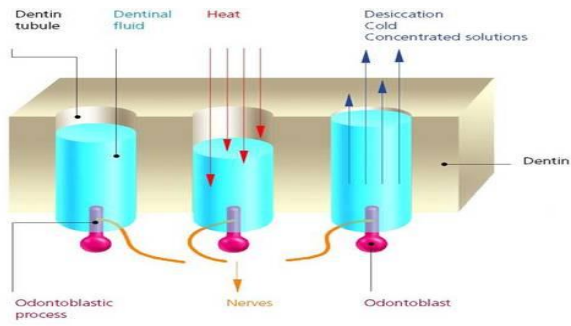
Ferracane JL. Can interaction of materials with the dentin-pulp complex contribute to dentin regeneration. *Odontology* 2010;98:2-14.

EFFECT OF CAVITY PREPARATION

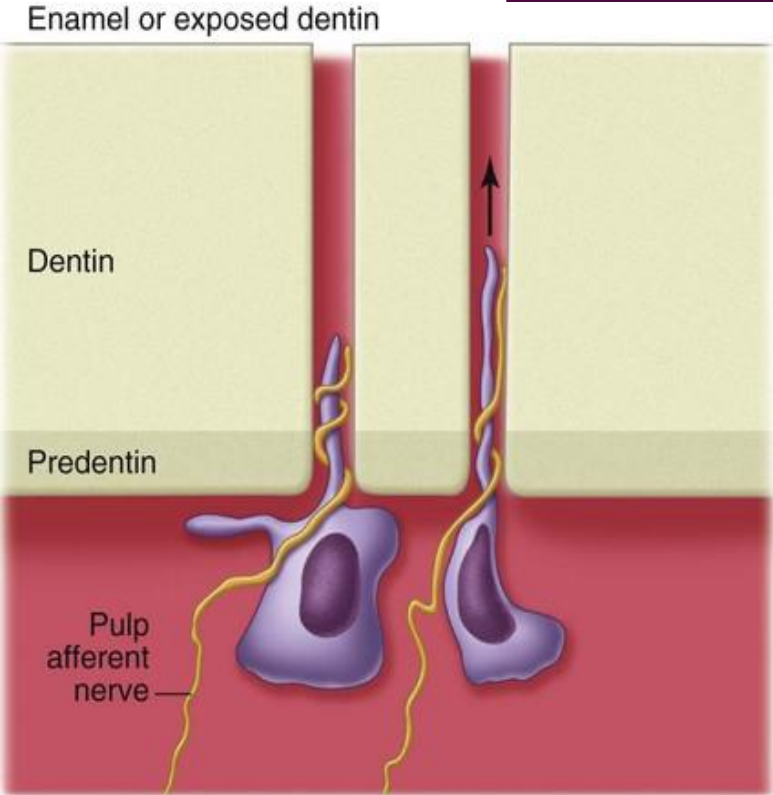
“Cooking the pulp in its own juice”

Tooth preparation without proper water coolant leads to more frictional heat generation and transection of the odontoblastic processes, dessication of dentin and pulp exposure.





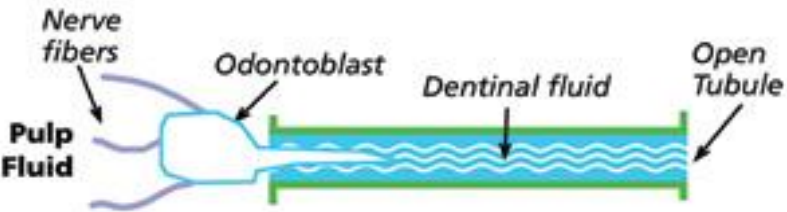
DENTINAL FLUID



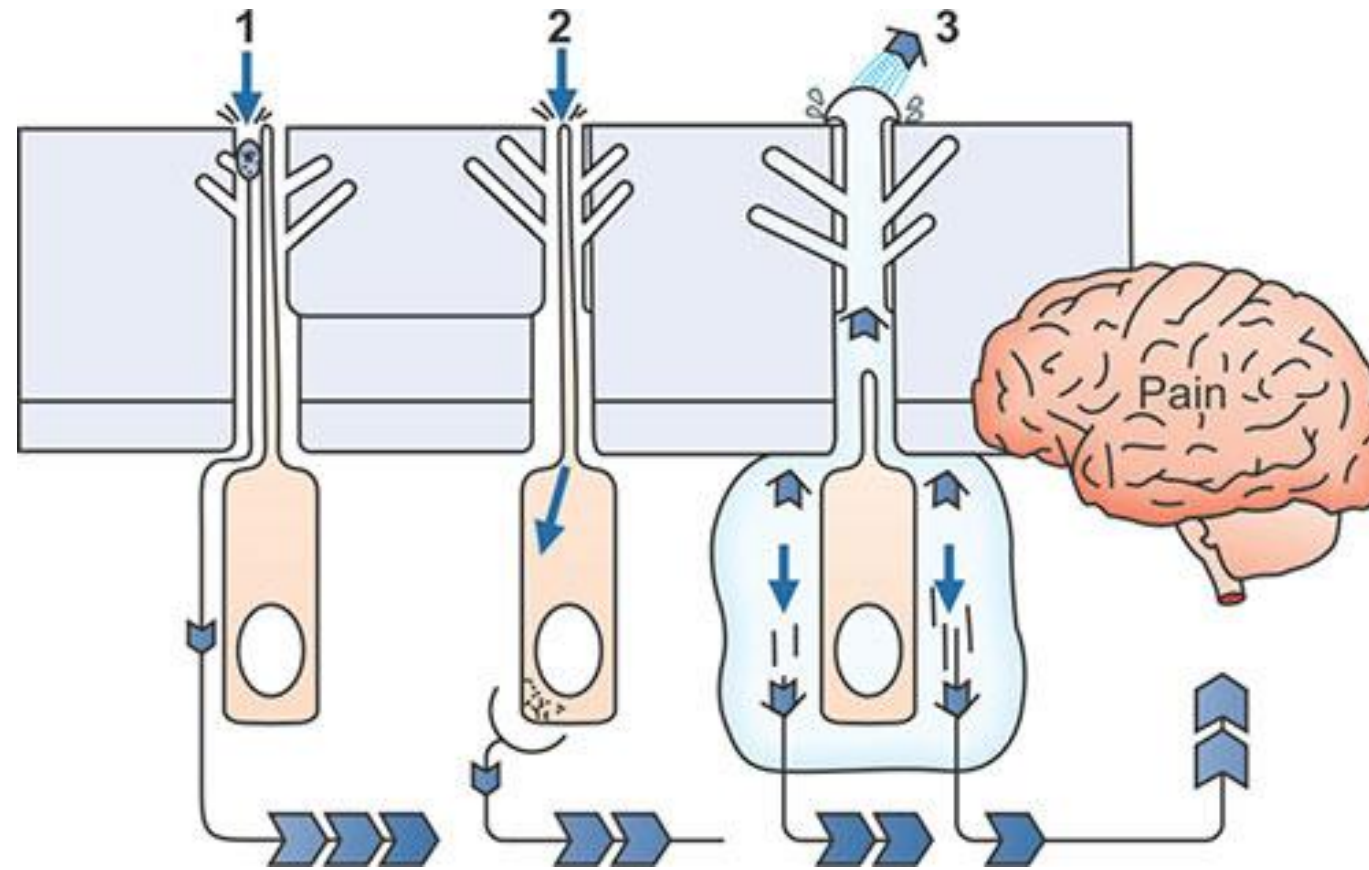
Interstitial Fluid in the dentinal tubule is called dentinal fluid.

All stimuli produce movement of dentinal fluid and excitation of sensory A δ nerve fibers.

A δ nerve fibers produces sharp pain for short duration .



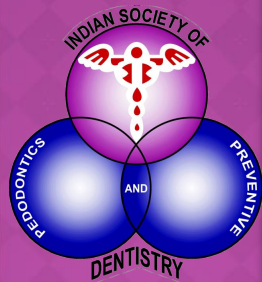
THEORIES OF DENTIN SENSITIVITY



Neural theory

Odontoblastic transduction theory

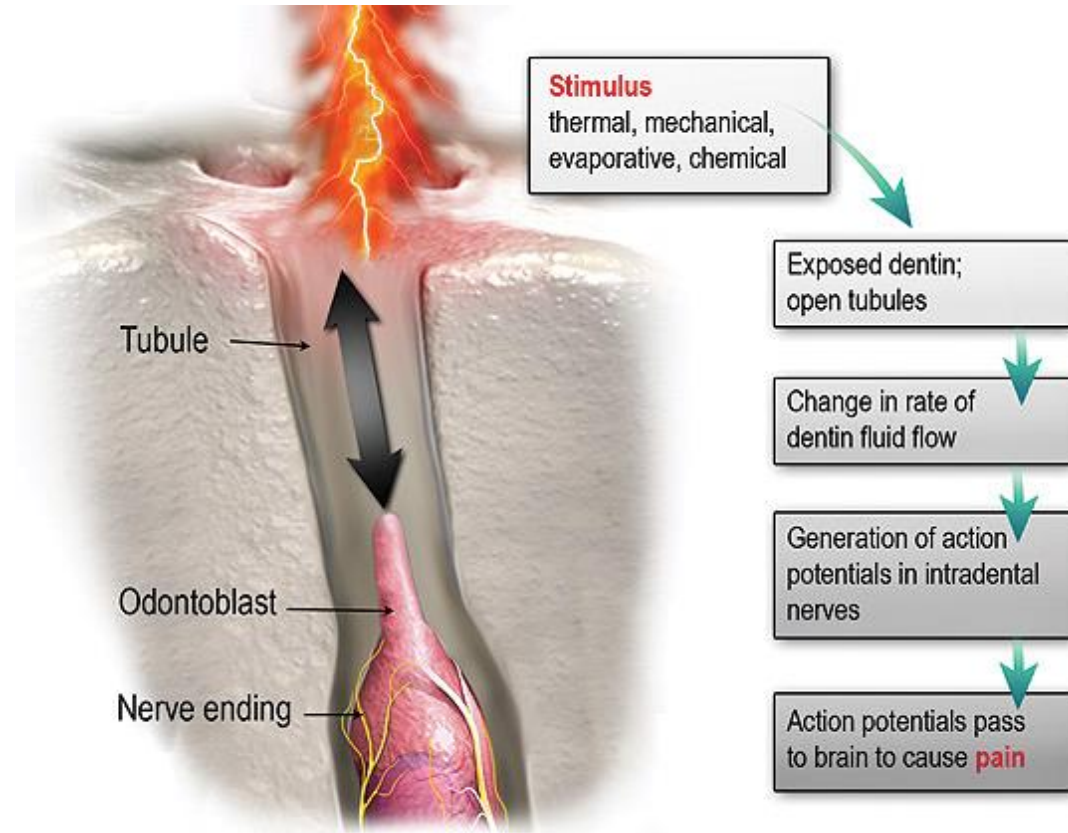
Hydrodynamic theory



BASED ON - HYDRODYNAMIC THEORY

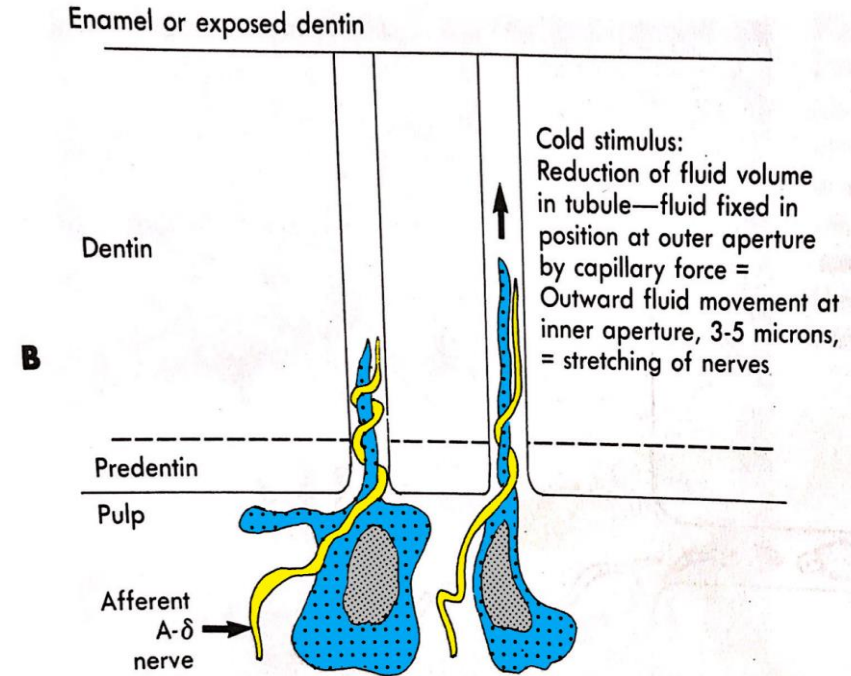
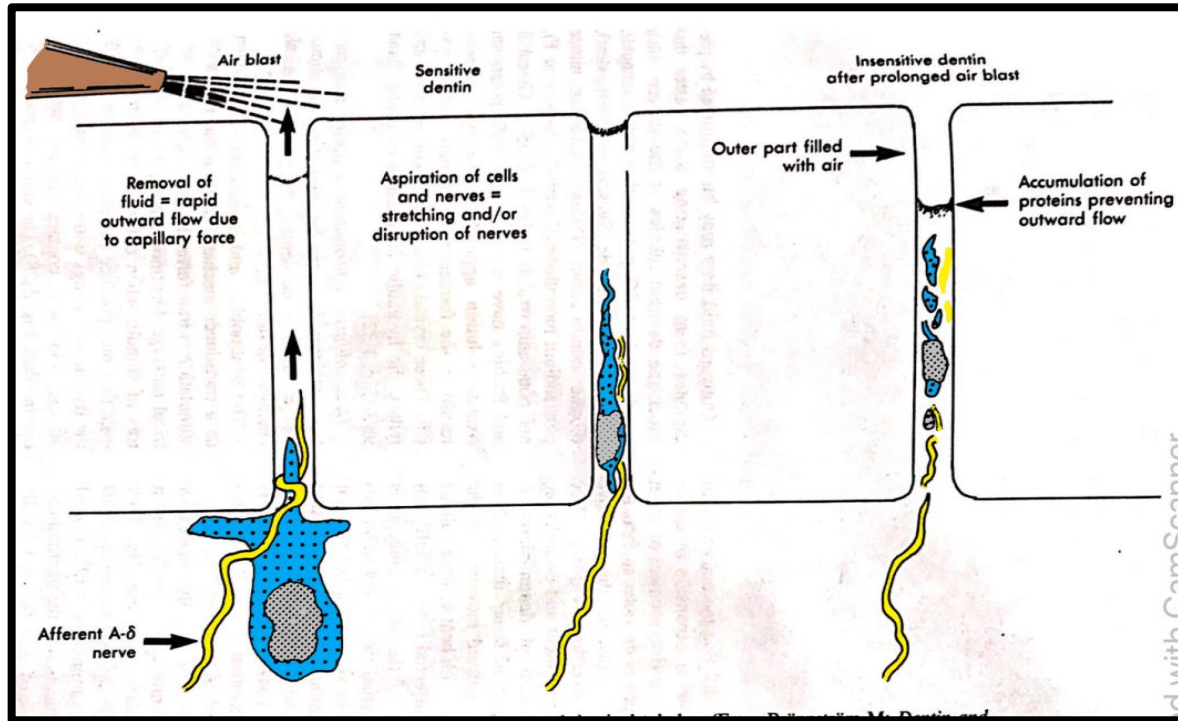
- Proposed by Brannstrom
- The coefficient of thermal expansion of tubule fluid is about **ten times** that of the tubule wall, therefore, **heat applied** to dentin will result in expansion of the dentinal fluid, and a **cold stimulus** will result in contraction of the fluid, both creating an excitation of the “mechanoreceptor”

Berman



WHAT HAPPENS TO ODONTOBLASTS WHEN A 3 WAY SYRINGE IS USED?

WHAT HAPPENS TO ODONTOBLASTS WHEN SUBJECTED TO COLD, HEAT AND SWEET?



- Air initially causes sensitivity
- Compressed air applied for long time, it becomes insensitive for 20mins due to blockage of fluid flow by proteins

Heat expands so no pain
Sweet –create osmotic gradient –fluid movement –sensitivity/sharp pain.

THE DEFENSE MECHANISM

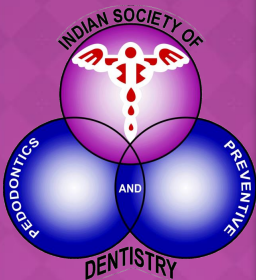
• Dentinal Pain

• The smear layer

• Tubular sclerosis

• Irritational(repairartive)dentin formation.

• Inflammation of the connective tissue.



Cell Free Zone/Zone of Weil

Below the odontoblastic layer is the cell-free zone that contains some fibroblasts, macrophages.

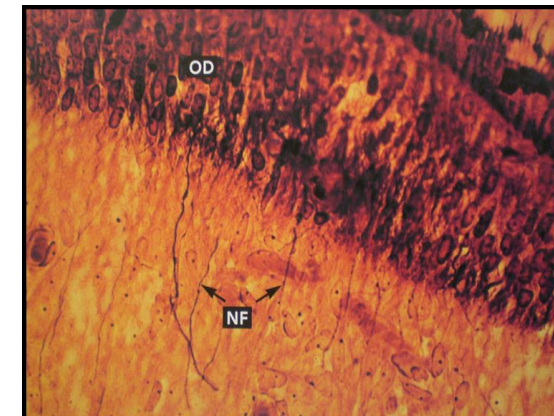
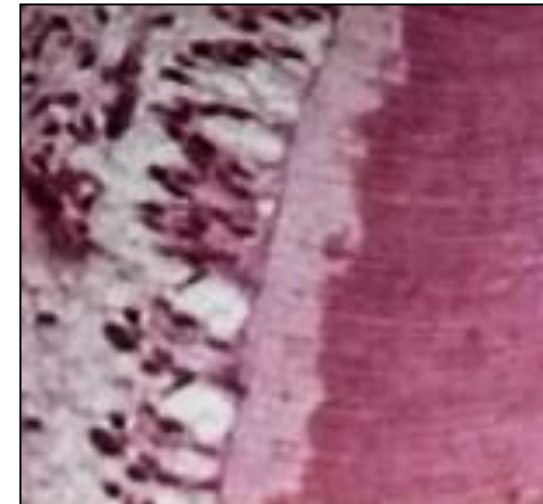
Mainly contains terminal blood capillaries, Plexus of Rashkow and ground substance.

It provides nutrition to odontoblastic cell bodies by terminal capillaries.

It contains nerve fibers that are specific receptors for pain.

It diminishes in size when dentin is formed (tertiary dentin).

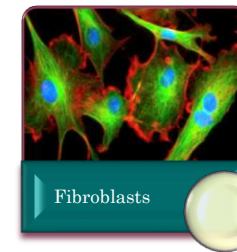
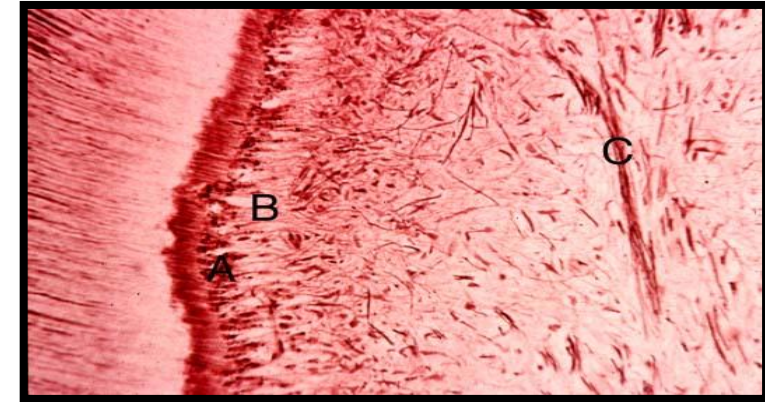
Is it really cell free?



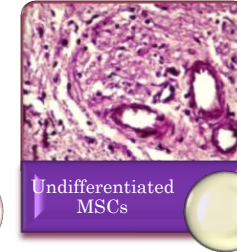
CELL RICH ZONE

Located central to cell free zone.

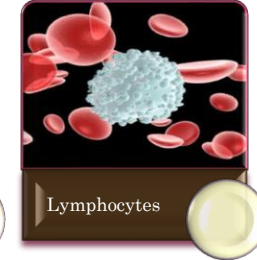
It contains *fibroblasts, undifferentiated mesenchymal cells, macrophages, dendritic cells & lymphocytes.* and *ground substance.*



Fibroblasts



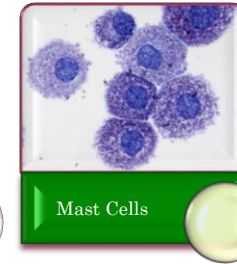
Undifferentiated MSCs



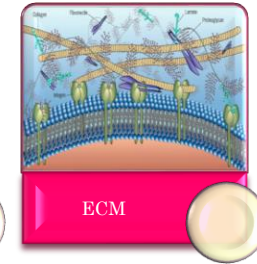
Lymphocytes



Macrophages



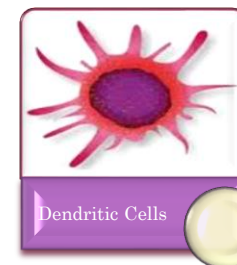
Mast Cells



ECM

Serves as a **reservoir** for replacement of destroyed odontoblasts.

Ground substance serves as transport medium for metabolites and waste products.



Dendritic Cells

CELL RICH ZONE



○ Fibroblasts :

○ Clinical significance:

Active factories of pulp and most predominant cells..

This fibers are more in apical which protects neurovascular bundle.

It involved in formation and degradation of collagen.

Differentiates to new odontoblasts.

What is “**crabgrass effect**”?

Pulp chamber becomes narrower with age

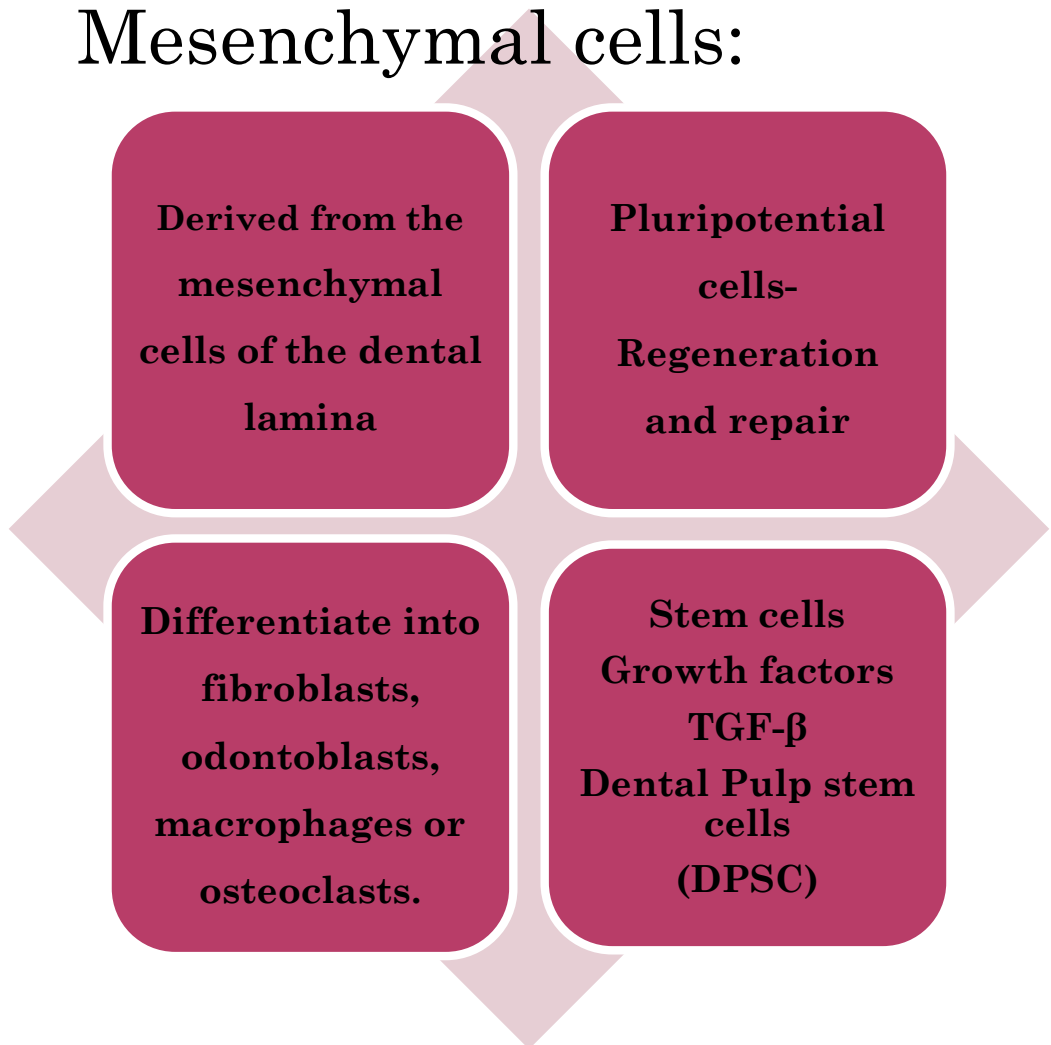
Collagen’s inability to disintegrate to accomodate in the smaller lumen-***fibrosis***

This congestion is called as “**Crabgrass effect**”

Pulp comes out easily when we extirpate pulp during pulpectomy?.

CELL RICH ZONE

○ Undifferentiated Mesenchymal cells:

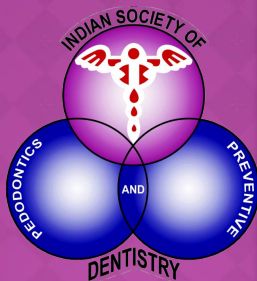


○ Clinical significance:

Reservoir for replacing lost odontoblasts.

Regenerative endodontics

In primary teeth when DPC treatment done undifferentiated mesenchymal cells causes internal resorption?



Why DPC is Contraindicated In Primary Teeth???

28



Localization Of Infection & Inflammation in Primary Teeth is Poorer than in Permanent Teeth.

[Mc Donalds,1956]

Incidence of reparative dentin formation in primary teeth is more extensive than permanent Teeth.

[Sayegh , 1968]

Primary pulp contain high cellular content which might be responsible for failures. Primary pulp responds more rapidly to the effects of dentinal caries then the perm. Teeth.

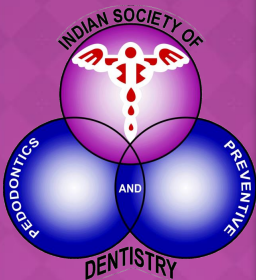
[Rayner & Southam, 1979]

Undifferentiated mesenchymal cells may differentiate into odontoclasts in response to caries or pulp capping material which could lead to internal resorption.

[Kennedy,1985]

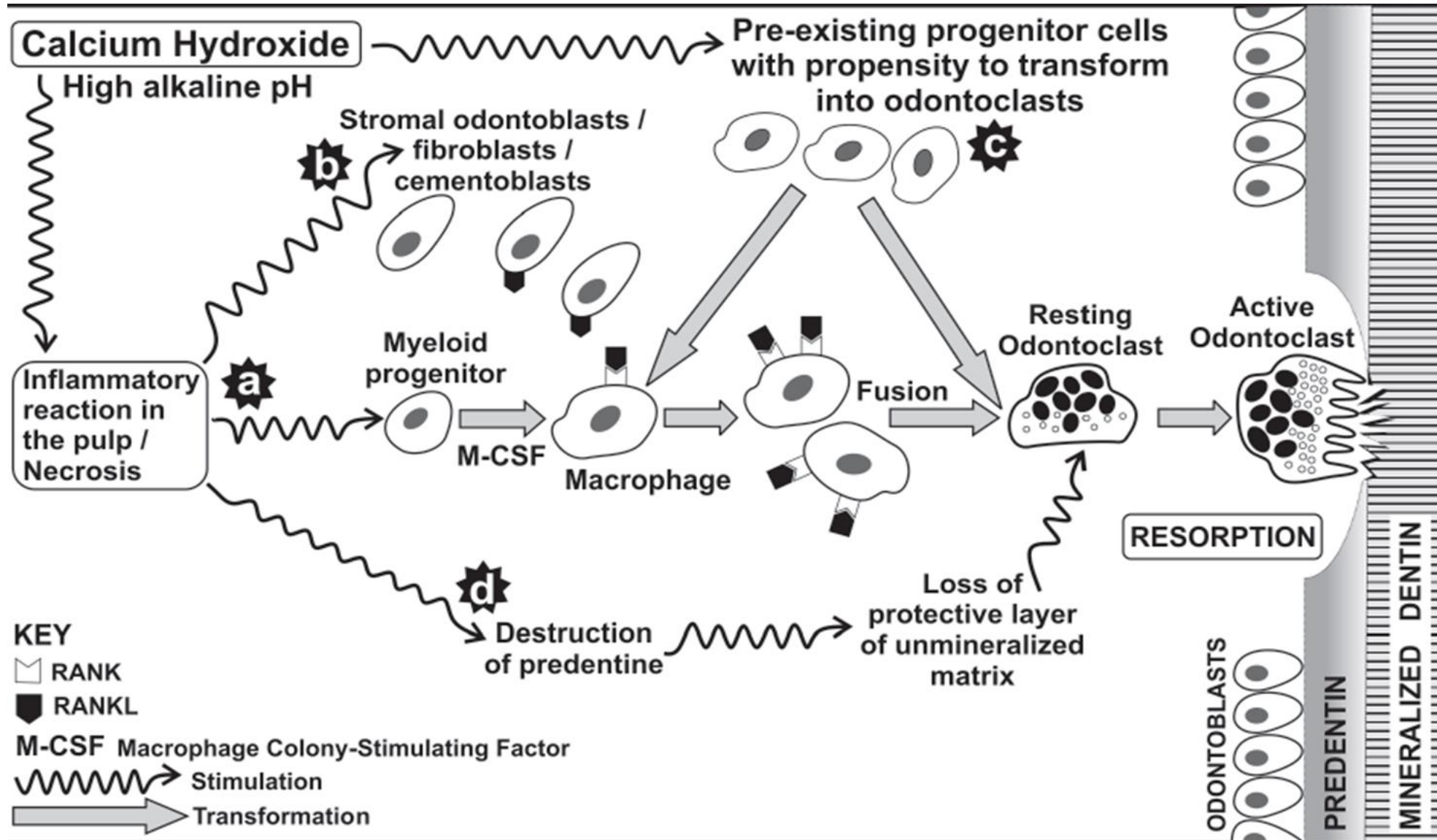


Courtesy:Dr.Raghvendra Havale



Proposed mechanisms for lack of dentine bridge formation in deciduous tooth pulp in presence of calcium hydroxide (Ca(OH)₂)

Ravi GR, Subramanyam RV, 2015



COMMONLY ASKED QUESTIONS:

- Why children have lesser tooth sensitivity/pain than adults?
- While preparing cavity preparation why there is pain when we go towards dentine?
- In children why caries spreads faster than adults?
- Why only cold and sweet increases sensitivity or sharp sensation than hot beverages.
- What do you mean by “**Calcitraumatic line**” & its significance.
- What is interphase dentin?
- What do you mean by “**cooking of pulp in its own juice**” and its significance.
- How do you differentiate between hypersensitivity and reversible pulpitis?
- What are the scientific names of IPC and DPC?
- Which cells are called as active factories of pulp?
- Why direct pulp capping is not successful as compared to permanent teeth?
- What is the amount of reparative dentine formation per day?
- Why collateral circulation is not present in pulp?
- What is the normal intrapulpal pressure of the pulp?
- Where A δ and C fibers present in the tooth and what type of pain they produce?

IMPORTANCE IN DENTISTRY ???

Q: Pain increases as we go toward pulp while cavity cutting.

- During cavity preparation the junctions are disrupted and there by increase the dentin permeability.
- As the fully mature odontoblasts migrates pulpally, the processes unite to form single dentinal tubules at the DEJ. So there is extreme sensitivity of the DEJ.
- Crowding of dentinal tubules at the predentin due to reduction of pulp chamber by deposition of dentin giving “S” shape in permanent teeth. (J.Dent Res1989 68:1262)

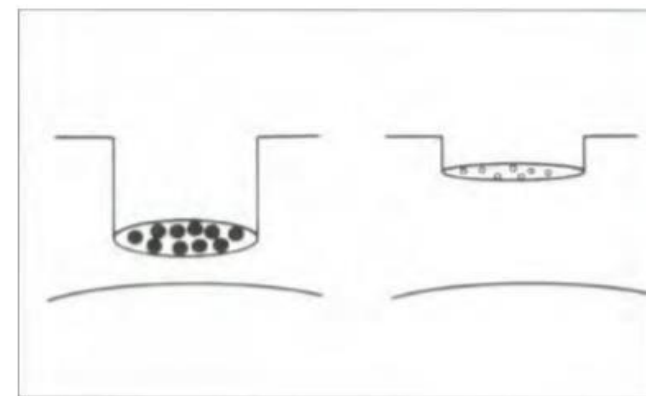
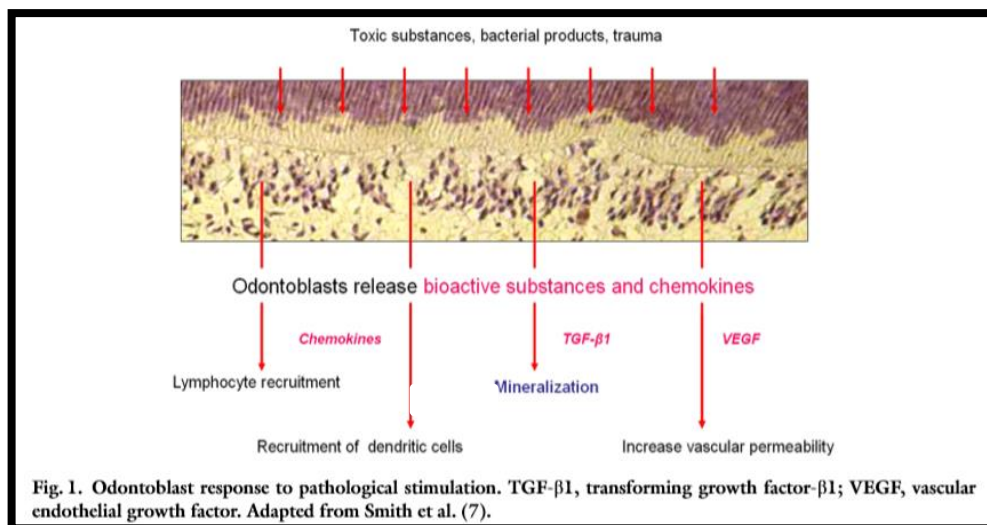


Fig 3-9 Schematic diagram of the differences in tubular density of the floor of a shallow (right) and deep (left) cavity prepared in dentin.

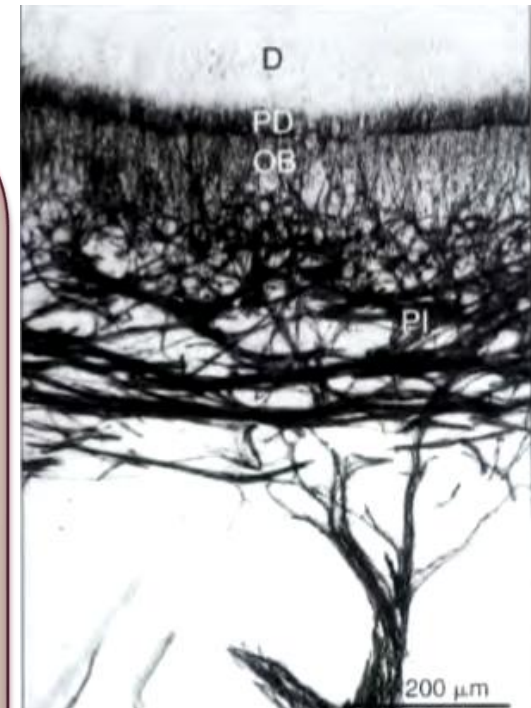
SOME INTERESTING QUESTIONS...

Question:

Why do the children have less pain during cavity preparation or less perception on pulp testing ?

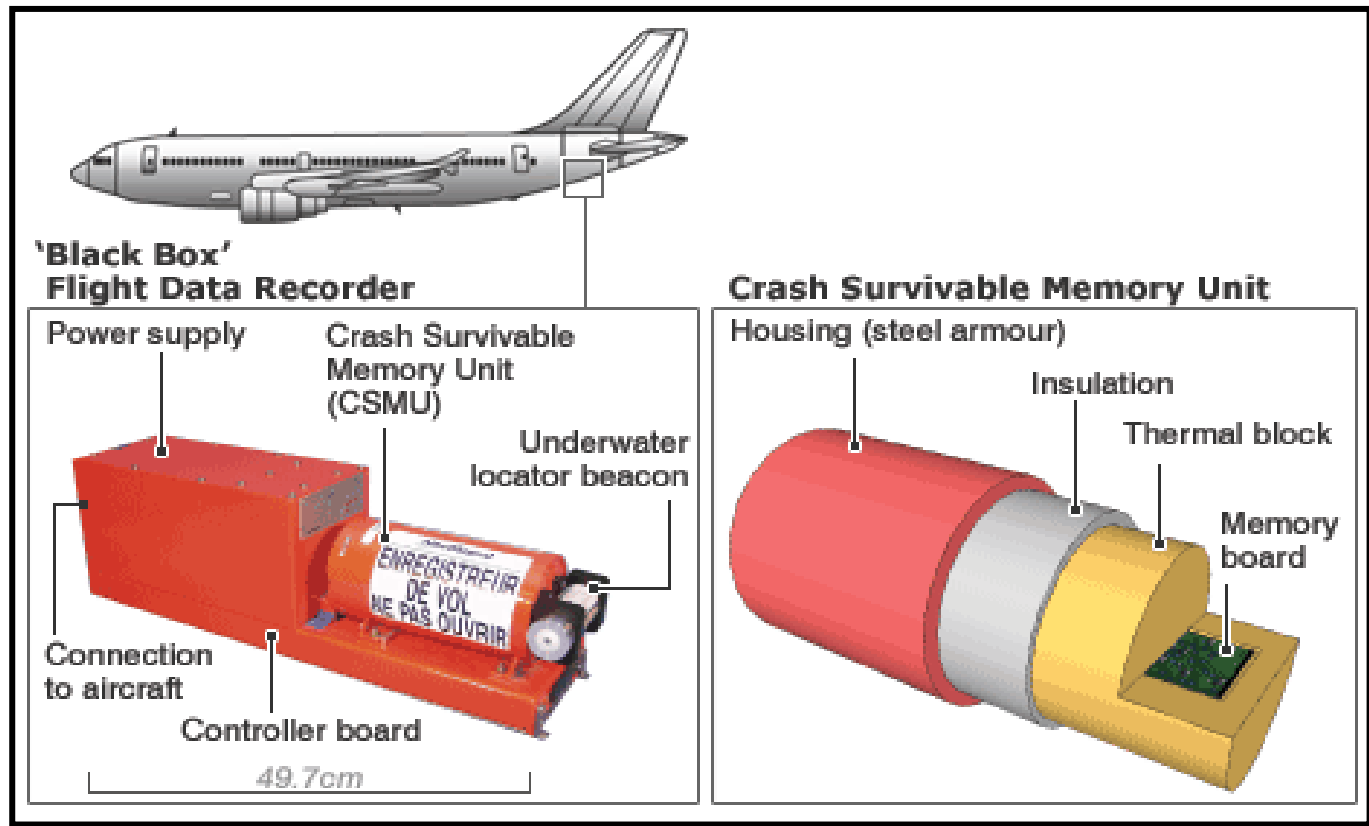
Answer:

- Nerve fibers are limited to odontoblastic zone or predentin in primary teeth.
- Crowding of dentinal tubules is less at the predentin so giving straight shape compare to “S” shape in permanent teeth.
- Density of the nerve innervation is less (Rapp)
- Both primary and immature permanent teeth are not fully innervated with alpha myelinated axons, the neural components which are responsible for the pulpal pain response.



DO YOU KNOW WHY ?

Dental pulp is called a black box ???



DENTAL PULP AS A BLACK BOX

- Circulatory Dynamics
- Pulp tissue shows the status of whole tooth structures and body as it has got rich vascular supply like any other organ of the body viz brain, heart, kidney, viscera, skin etc..

12

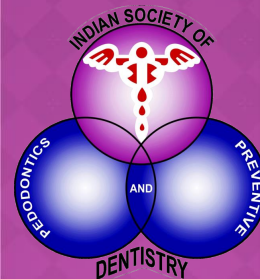
Concluding remarks

S. KIM

Major advances have been made in the study of the circulation in many parts of the body, especially in the area of microcirculation. Until recently, in investigations of circulatory dynamics in various regions of the body, the organ or the system was usually treated as a black box. The only measurements taken were of the flow through the region and the pressure drop from the large arteries to the large veins (Fig. 1). The resistance to flow can then

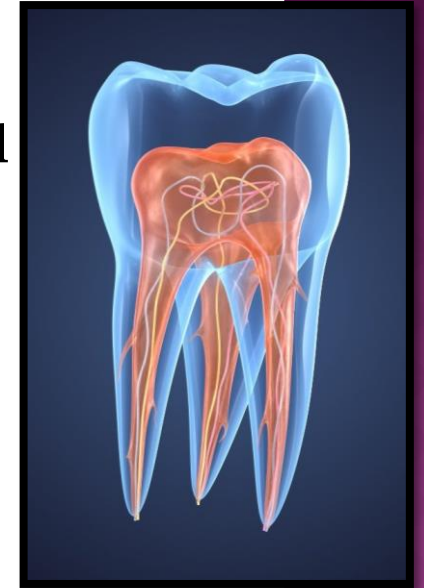
The dental pulp has been a 'black box' from the physiological perspective until recently. The early years of research on the pulp focused on structures, because methods sufficiently sophisticated to examine the dynamics of the pulp had not yet been developed. With advancements in electronics, radioisotope and laser technologies, however, pulp physiologists have slowly but steadily unscrambled the content of the 'black box'. It is generally acknowledged that the greatest advancement in pulp physiology research has occurred in the past decade, and this section on the pulp represents the finest collection of that research by key researchers. We are now in a position to make structural-functional correlations of the pulp in health and disease. A similar linkage must

Chien S. Hemodynamics of the dental pulp. Journal of dental research. 1985 Apr;64(4):602-6.



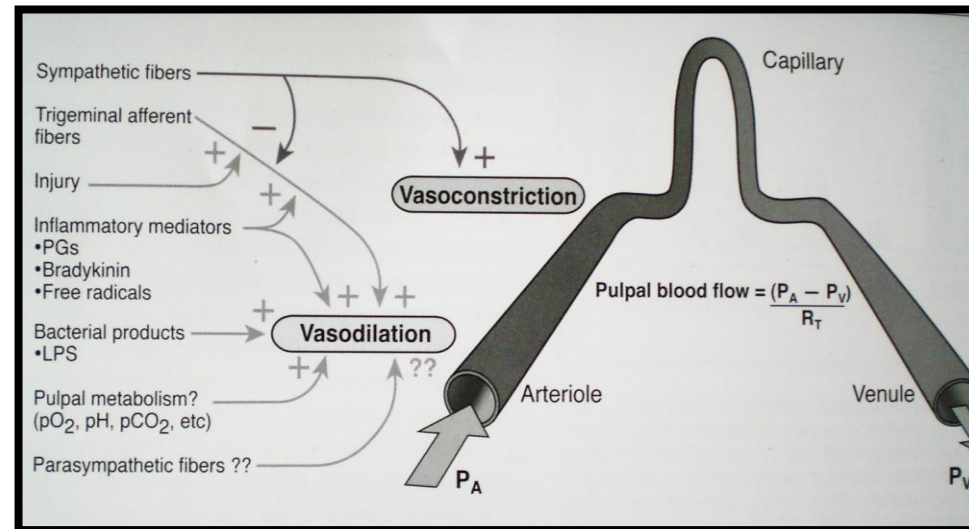
PULPAL MICROVASCULATURE

- The anatomical limitation of encasement makes the pulp an organ of **terminal circulation**, with limited portals of **entry and exit: the apical and accessory foramina**. This feature limits the vascular supply and drainage of the pulp and thereby **limits collateral circulation**.



The arterial supply of the pulp has its origin from the

- Posterior superior alveolar arteries
- Infra orbital artery and
- The inferior alveolar branch of the internal maxillary artery.



PULPAL MICROVASCULATURE

Studies of pulp vessels

The blood flow per unit volume per minute is 125ml/min/100 g tissue in the coronal pulp.

The blood flow per unit volume per minute is 22 ml/min/100 g tissue in the apical pulp

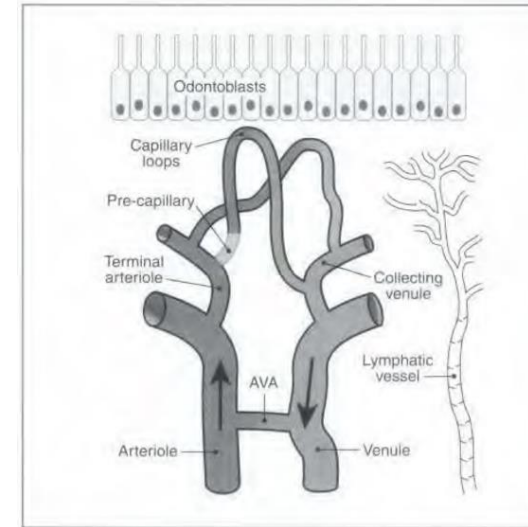
Compared to other connective tissue in the body, the dental pulp has a high resting blood flow of 40 to 50 mL/Min/100g

Odontoblasts consume oxygen at the rate of 3.2 ± 0.2 ml/min/100g of pulp tissue.

Van hassle, Beveridge & Brown

- Mean intrapulpal pressure – 10 mm - Hg. Normal tooth.
- Slight inflammation – 13mm Hg – reversible status of pulp.
- A pressure of 35mm Hg –irreversible status of pulp.

LYMPHATICS

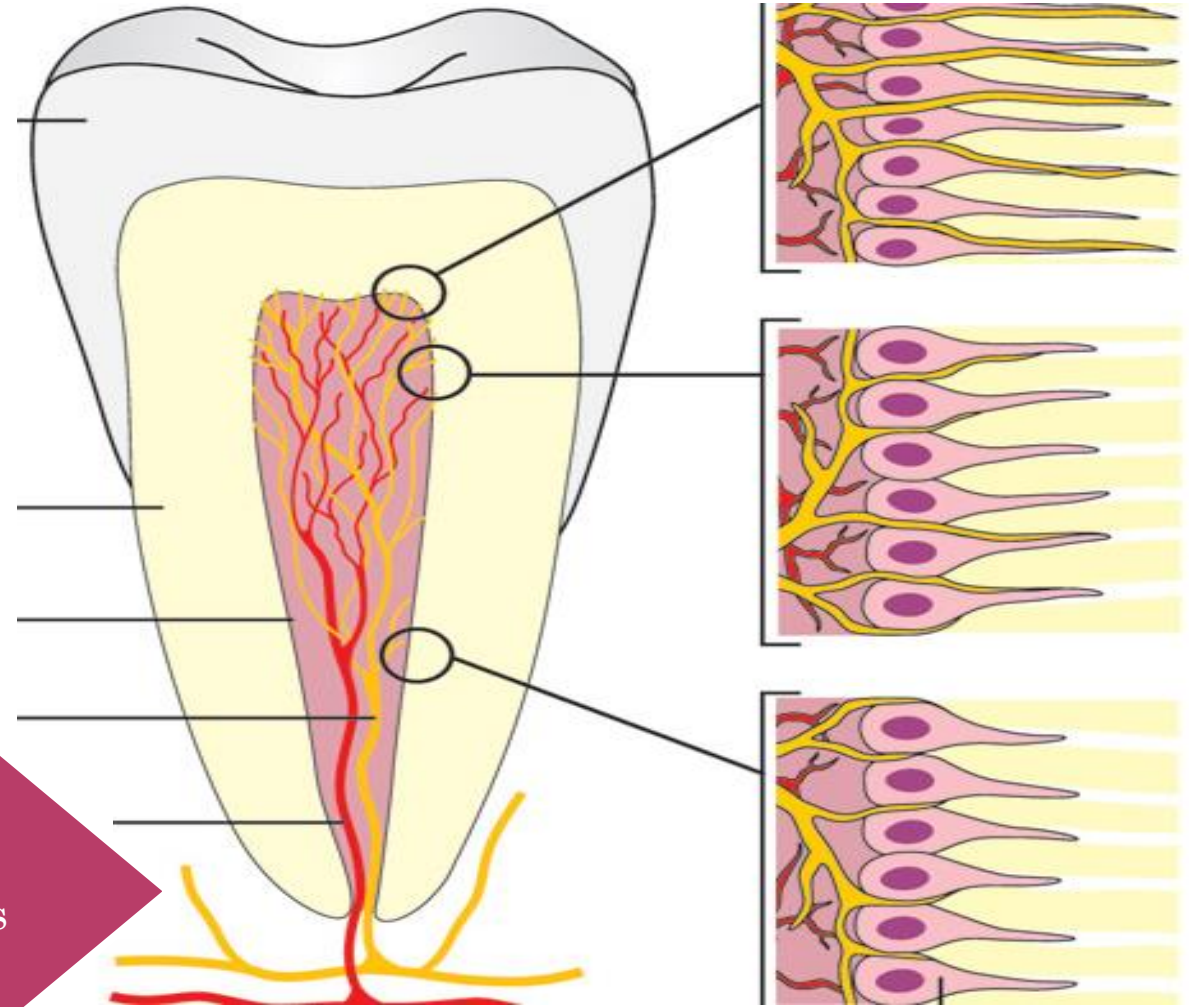
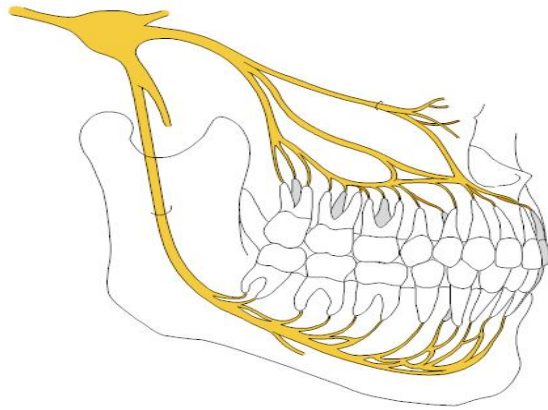


Function:-

Removal of interstitial fluid and metabolic waste products.

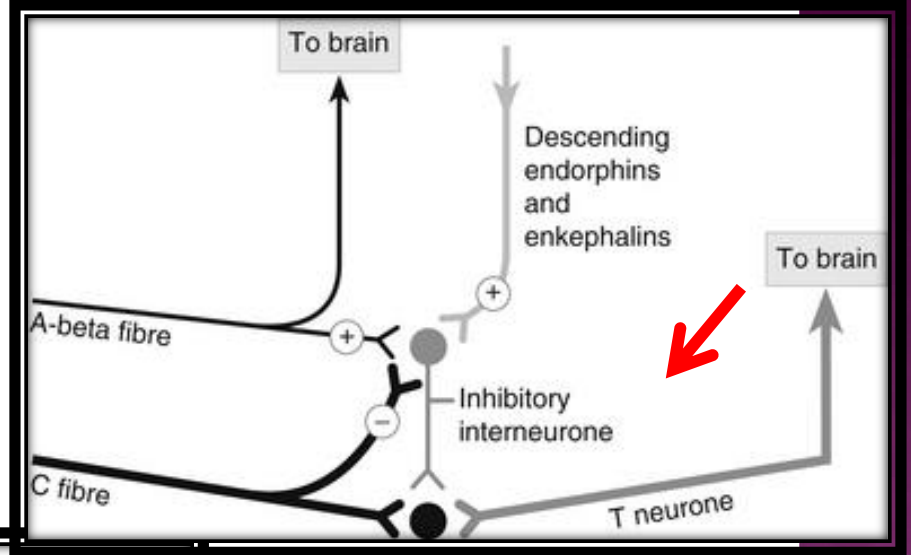
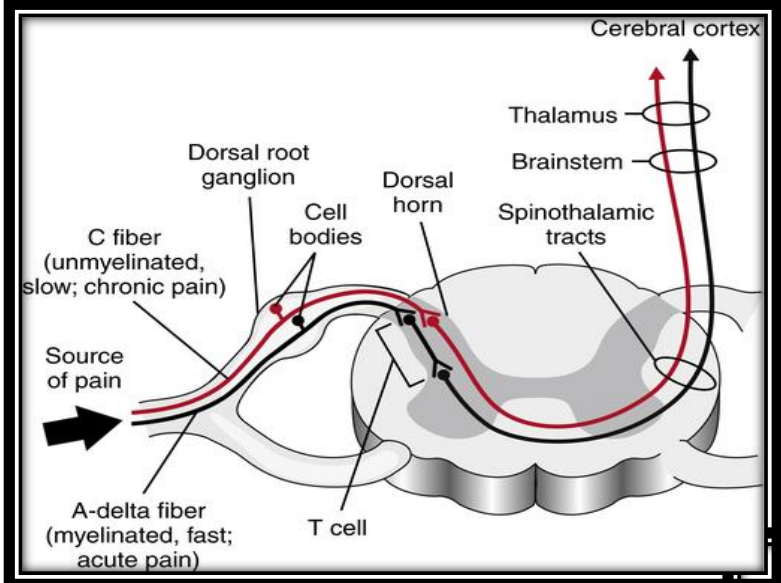
To maintain the **intrapulpal tissue pressure at a normal level (10mm of Hg).**

INNERVATION OF PULP



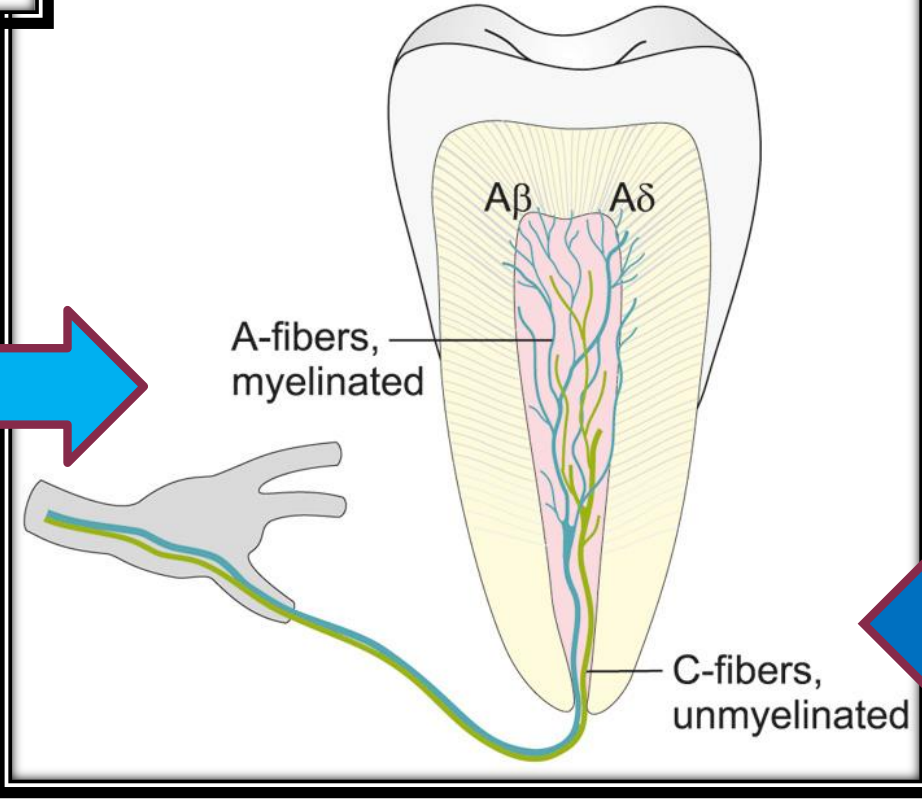
Sympathetic(ANS)
: control the contraction of blood vessels.

Sensory nerves:
maxillary and mandibular divisions of trigeminal nerve.



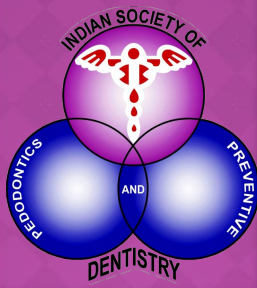
Sharp, piercing lancinating pain

- Superficial
- First to react
- Slight stimulation



Slow, dull, aching pain

- Intense stimuli
- Deep location/diffuse/referred pain
- Hypoxia survival



PULP FIBERS IN THE PULP

Characteristics	A δ Fibers	C Fibers
Diameter	2-5 μ m	0.3-1.2 μ m
Conduction velocity (m/sec)	5-30	0.4-2
Myelination	Yes	No
Location	Superficial in predentine and pulp dentine border	Deep near blood vessels throughout pulp.
Pain Characteristics	Fast and Momentary Sharp, Pricking, unpleasant but bearable	Throbbing, Aching and less bearable; Lingering and extremely unbearable
Stimulation Threshold	Low, can be stimulated without tissue injury.	High; Intense stimulus as tissue damage is there.
Clinical applications	Stimulated in physiological and reversible condition	Stimulated in pathological condition or when tissue injury.

PAIN PERCEPTION IN CHILDREN

DUAL NATURE OF PAIN

Pain Perception:

It is the physio-anatomical process whereby impulse is generated, following application of adequate stimulus and transmitted to the central nervous system.

It is similar in all individuals.

Pain reaction:

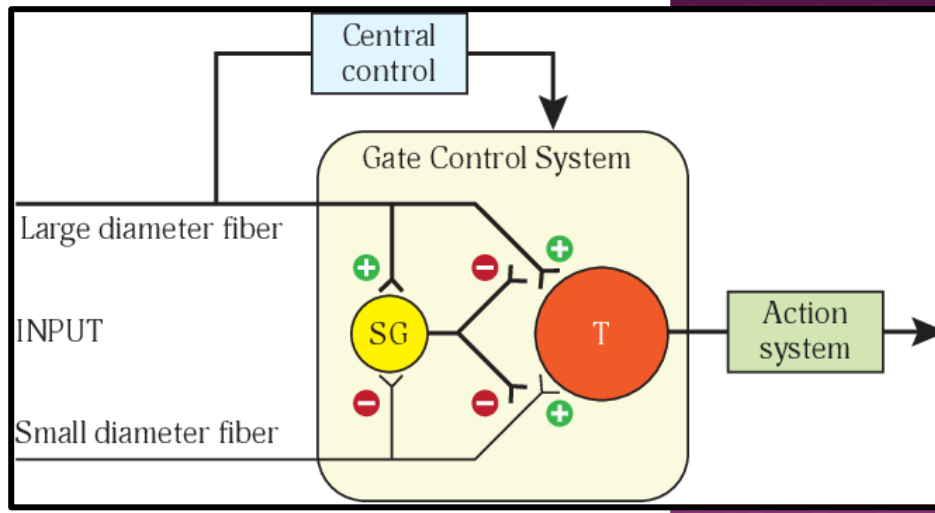
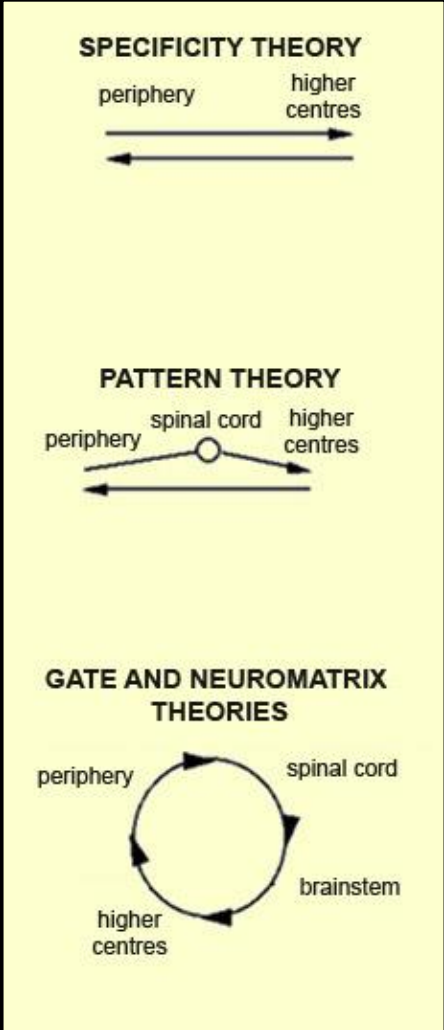
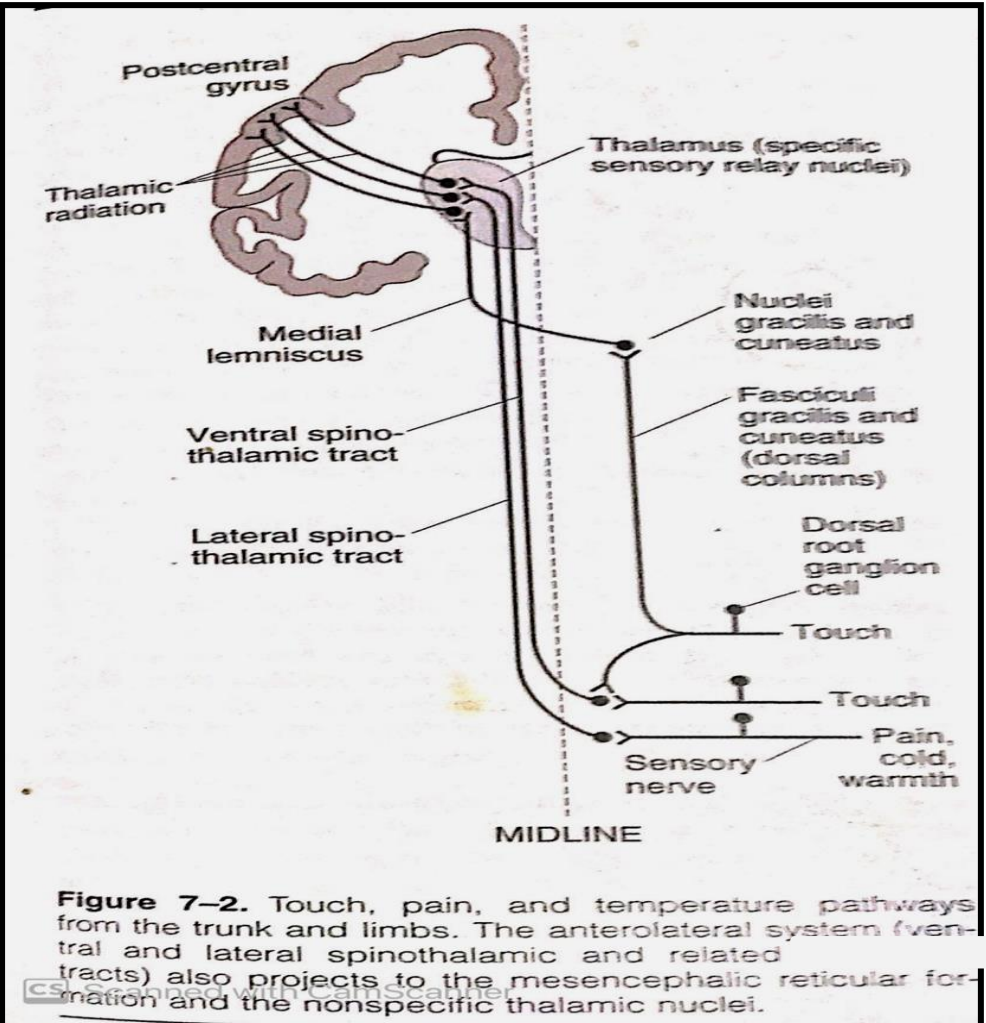
It is a psycho-physiological process that represents the overt individual's overt manifestation of the unpleasant perceptual process that just occurred.

Extremely complex

Varies from person to person.

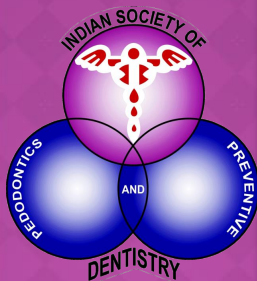
Pain reaction threshold is inversely proportional to pain reaction.

PAIN PATHWAY



GATE CONTROL THEORY OF PAIN

THEORIES OF PAIN

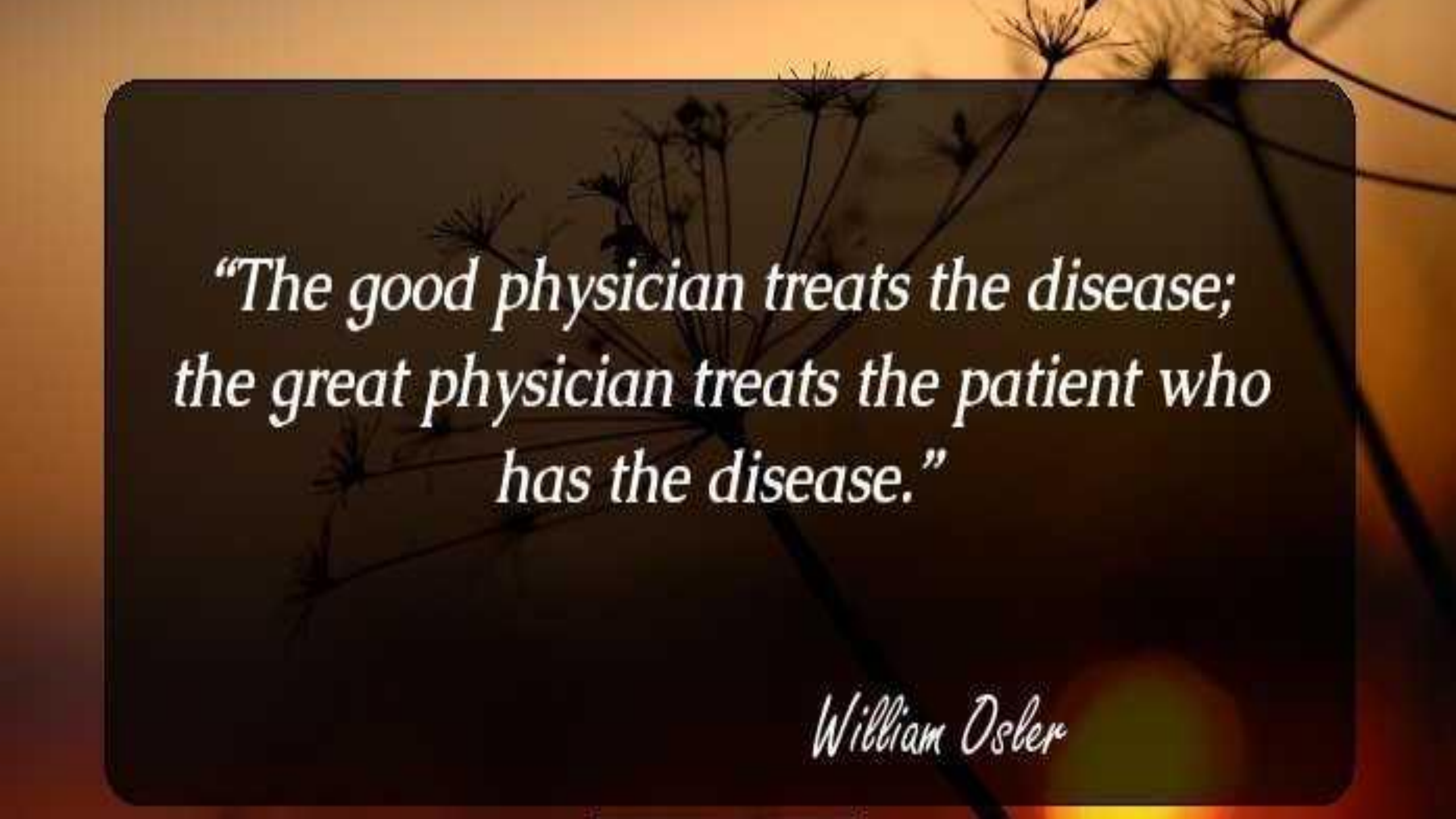


SATURDAY NIGHT OR SUNDAY MORNING PARALYSIS.

Local anesthetics depress transmission in the group C fibres before they affect the touch fibres in A group. Conversely, pressure on a nerve can cause loss of conduction in large diameter motor, touch and pressure fibres while pain sensation remains relatively intact.

Patterns of this type are sometimes seen in individuals who sleep with their arms under their heads for longer periods, causing compression of the nerves in the arms.

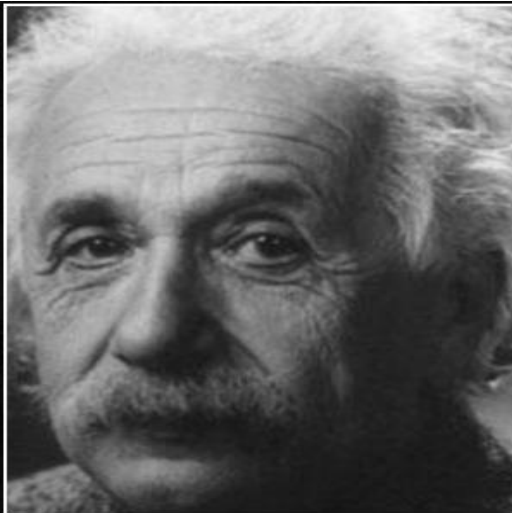
Because of the association of deep sleep with alcoholic intoxication, the syndrome is commonest on weekends and has acquired the interesting name **Saturday night or Sunday morning paralysis.**

The image features a quote by William Osler centered on a dark, rounded rectangular background. The background is a gradient of warm colors, from light orange at the top to dark brown at the bottom. A silhouette of a plant with several thin stems and small, spiky flower heads is visible, extending from the top and right sides of the frame. The quote is written in a white, serif font with a slight shadow effect.

*“The good physician treats the disease;
the great physician treats the patient who
has the disease.”*

William Osler

DISEASES OF THE PULP



A little knowledge is a dangerous
thing.

— *Albert Einstein* —

AZ QUOTES



CLASSIFICATION OF DISEASES OF THE PULP

1. Inflammatory diseases of the dental pulp

(a) Reversible pulpitis

i) Symptomatic (acute)

ii) Asymptomatic (chronic)

(b) Irreversible pulpitis

I. *Acute*

(i) Abnormally responsive to cold

(ii) Abnormally responsive to heat

II. *Chronic*

(i) Asymptomatic with pulp exposure

(ii) Hyperplastic pulpitis

(iii) Internal resorption

2. Pulp degeneration

(a) Calcific (radiographic diagnosis)

(b) Others

3. Pulp necrosis



Grossman L. The Dental Pulp And Periradicular Tissues. Chandra S, Gopikrishna V., editor. Grossman's Endodontic Practice-13th ed. Haryana Wolters Kluwer. 2016 September. p 89-94.

CLASSIFICATION BY WEINE



1. Pulpitis

2. Hyperalgesia
(reversible pulpitis)

Hyperaemia

3. Painful pulpitis

Acute pulpalgia

Chronic pulpalgia

4. Nonpainful pulpitis

Chronic ulcerative pulpitis

Chronic pulpitis (no caries)

Chronic hyperplastic pulpitis (pulp polyp)

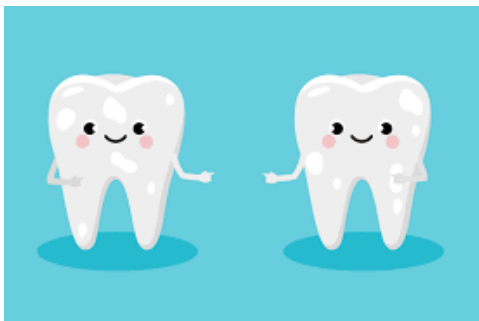
5. Pulp necrosis

6. Pulp degeneration

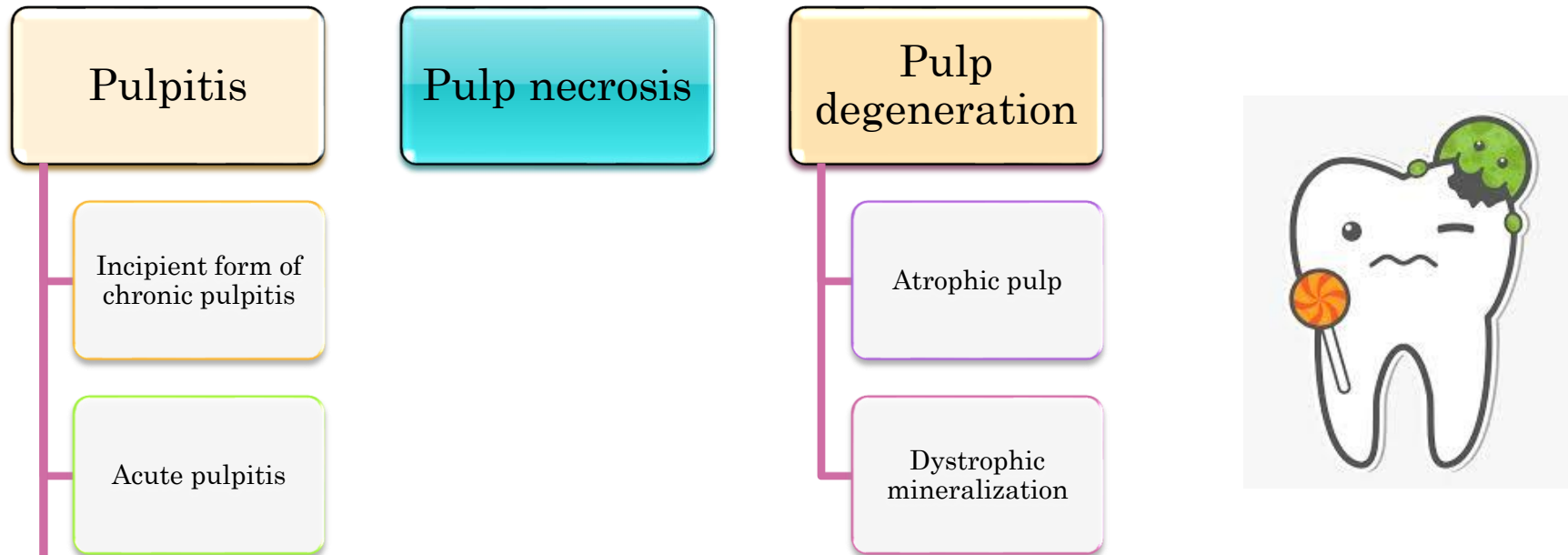
Atrophy

Dystrophic calcification

7. Internal resorption



Classification by SELTZER AND BENDER



- ✓ **Mild to moderate inflammatory** condition of the pulp caused by noxious stimuli in which the pulp is capable of returning to the uninflamed state following removal of the stimuli.



Radiographically : Normal on R/L examination.

SYMPTOMS

- ✓ **Sharp pain** lasting for a moment (**Short duration**).
- ✓ It is more often brought on by **cold, cold air, sweet, sour** than hot food or beverages.
- ✓ Goes away once stimuli is removed (**Subsides**)
- ✓ **Does not** occur spontaneously and does not continue when the cause has been removed.
- ✓ It is localised by **stimulus**.

IRREVERSIBLE PULPITIS

- Persistent inflammatory condition of the pulp, symptomatic or asymptomatic, caused by a noxious stimulus.
- Acute irreversible pulpitis exhibits pain usually caused by hot or cold stimulus, or pain that occurs **spontaneously**.
- The pain persists for several minutes to hours, lingering after removal of the thermal stimulus



Radiographically : R/L involving enamel, dentin and pulp.

SYMPTOMS

- The **severe dull aching**, piercing, shooting **pain often continues when the cause has been removed**, and it may come and go **spontaneously**, without apparent cause.
- The patient may describe the **pain on bending or lying down**.
- It is **intolerable, diffused and referred pain**.
- In later stages **boring, throbbing**. patients often remain **awake at night**.

COMPARTMENT SYNDROME:

Inflammatory edema that compromises blood supply to soft tissues and nerves in limited spaces with resulting ischemia is called compartment syndrome.

It is characterised by pain beyond what should be experienced from the initial injury. Also diminished sensation seen in distribution of nerve within a compartment that is compressed.

Clinical significance: The tooth becomes sensitive to thermal stimulation, & if necrosis commences, the pain becomes intense but it is poorly localized, difficult to identify the tooth.

After some days, the pain abates and the tooth becomes tender to palpation as the inflammatory proteins pour out of the apex to sensitize the suspending PDL. Symptoms are more like low grade infection, wherein pain is moderate to severe, throbbing in nature and easily localized.

Increase in Tissue fluid and intra pulpal pressure

Collapse of thin walled veins & venules

Decreased capillary blood flow & localized vascular stasis

Ischemia – Necrosis- oxygen deprivation

Compromised function of tissues and nerves within that space

CHRONIC HYPERPLASTIC PULPITIS

- ✓ Chronic hyperplastic pulpitis or "**pulp polyp**" is a productive pulpal inflammation due to an extensive carious exposure of a **young pulp**.
- ✓ This disorder is characterized by the **development of granulation tissue**, covered at times with epithelium and resulting from **long-standing, low-grade irritation**.

SYMPTOMS

- Symptomless except during mastication, when pressure of the food bolus may cause discomfort.
- The appearance of the **polypoid tissue**.



Radiographically : Large open cavities with direct access to the pulp chamber.

- ✓ Necrosis is death of the pulp. It may be partial or total.
- ✓ Necrosis, although a sequel to inflammation, can also occur following a traumatic injury in which the pulp is destroyed before an inflammatory reaction takes place.
- ✓ Ischemic infarction can develop - dry gangrenous necrotic pulp.

Radiographically : large cavity or filling, an open approach to the root canal, and a thickening of the periodontal ligament.
Asymptomatic. Necrotic pulp **does not respond** to cold, the electric pulp test, or the test cavity.

SYMPTOMS

- No painful symptoms.
- Discoloration of the tooth is the first indication that the pulp is dead.
- Dull greyish discoloration





ANSWER:

In primary teeth,

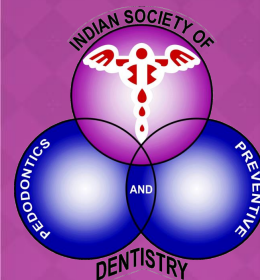
1. Furcation area is more porous
2. More accessory canals are located in the furcal area
3. Short cervical trunk
4. Long flared roots
5. Ribbon Shaped canals
6. Thin tortuous pulp filament

Why is it that in primary molar, radiolucency is seen in furcation area rather than apical region?



EFFECT OF PULPAL PATHOSIS ON INTRAPULPAL PRESSURE

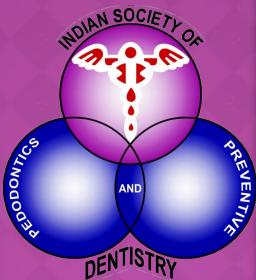
CLASSIFICATION	CLINICAL CONSIDERATIONS	NATURE OF PULP	AVERAGE INTRAPULPAL PRESSURE
Normal pulp		Structures intact; Tissue resilient; Usually extirpation in one piece	10 mmHg (range, 8-15)
Reversible pulpitis (Hyperalgesia)	Transitory pain, hyperactive pulp requires stimulus	Structurally intact but evidence of increased vascularity	13
Irreversible pulpitis	Pain may be spontaneous and persistent response to cold stimuli	Structurally intact; but engorged	34.5
Non-vital pulp, exudative	Heat maybe sensitive, Percussion sensitivity present	Fluid filled	35.6
Non-vital pulp, dehydrated	No response to vitality tests; periapical radiolucency maybe present	Dry granulated tissue ("mummy dust")	Unknown; capillary attraction of dentinal tubules and hygroscopic nature of canal contents may result in negative pressure.



A correct diagnosis is
three-fourths the remedy.

Mahatma Gandhi

quote fancy



DIAGNOSIS OF DISEASES OF THE PULP



Listen to your patient, he is
telling you the diagnosis.

~ William Osler



Why are children
not good historians

?

Age and behaviour can compromise reliability of pain.

More anxious & Fearful

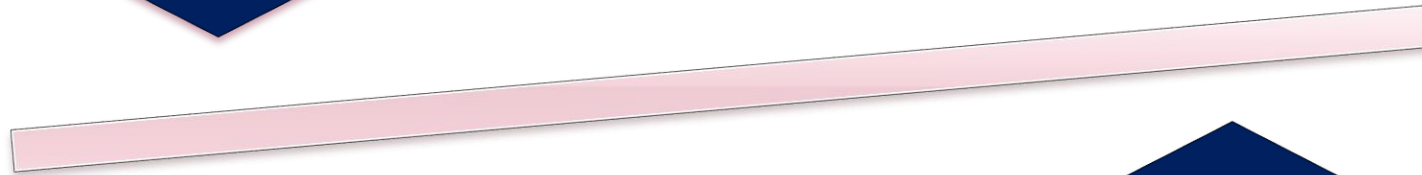
Reluctance towards the treatment – Gives false negative history(to avoid treatment)

Neural innervation - Both primary and immature permanent teeth are not fully innervated with alpha myelinated axons, the neural components which are responsible for the pulpal pain response.

SYMPTOMS



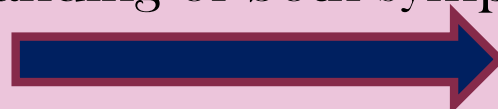
Subjective symptoms: Experienced and reported to the clinician by the patient



Objective symptoms: Ascertained by the clinician through various tests



Understanding of both symptoms



identification of disease



diagnosis of the problem



Pain



What exactly is spontaneous pain??

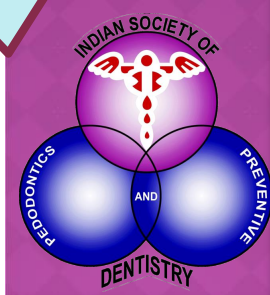


Quality of pain	How it feels to patient
Bright :	When patient has a stimulating or exciting type of pain
Dull	When the pain has a depressing effect - patient try to withdraw from work
Bright and tingling pain(Pricking)	Mild and stimulating pricking sensation
Itching pain	Superficial discomfort – does not reach pain threshold
Deep pain	Vague, diffuse, febrile, tenderness
Burning pain	When the discomfort has irritating, hot, raw, caustic quality.
Pulsating or throbbing	Increases with each heartbeat.
Spontaneous	Pain without any stimulus.

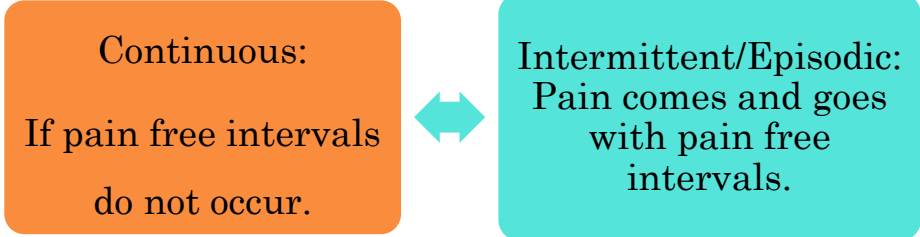
Acute vs chronic pain?



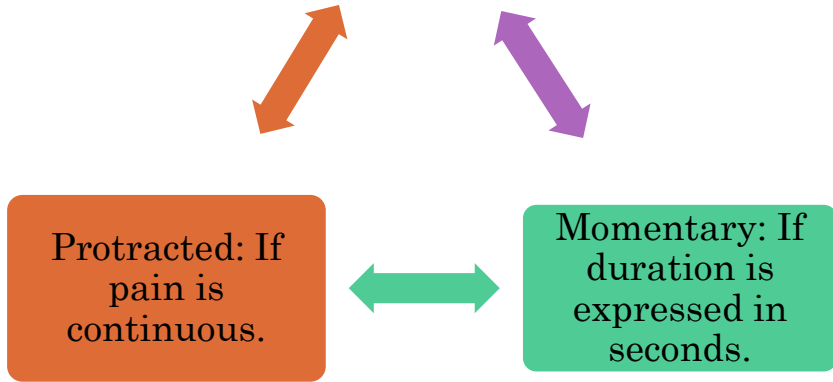
Throbbing vs dull aching pain??



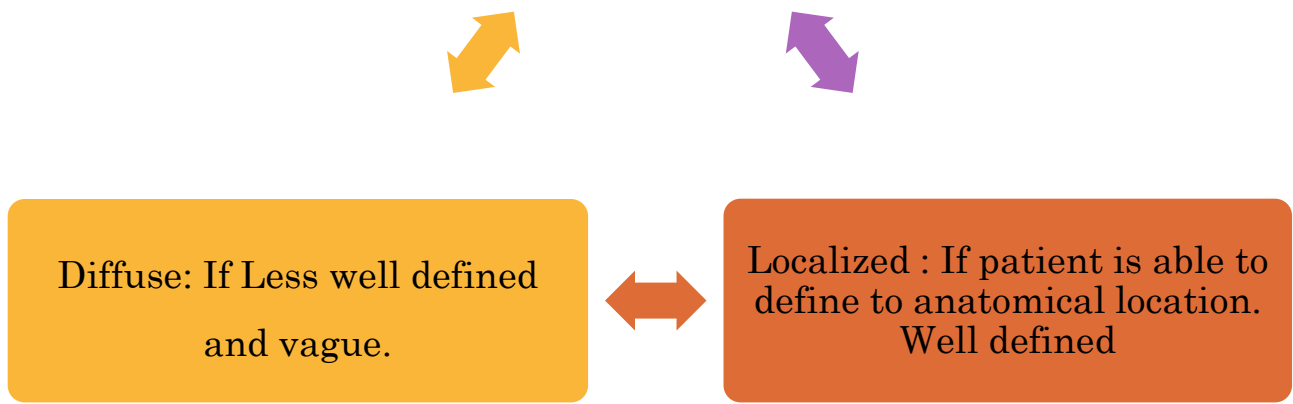
Behaviour of pain

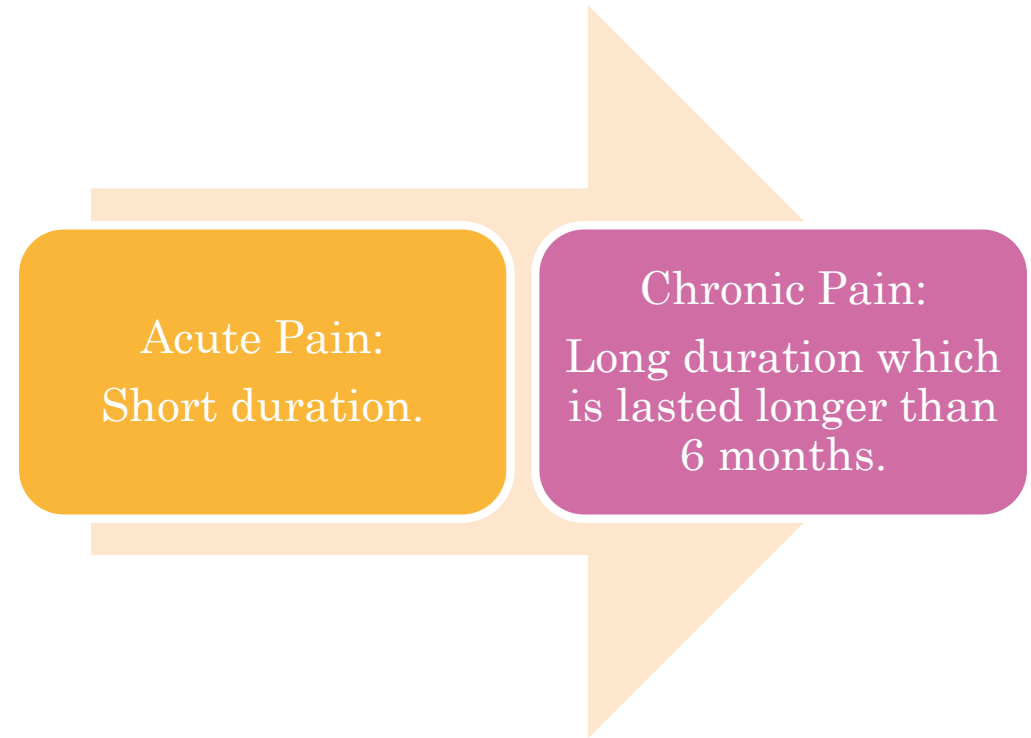
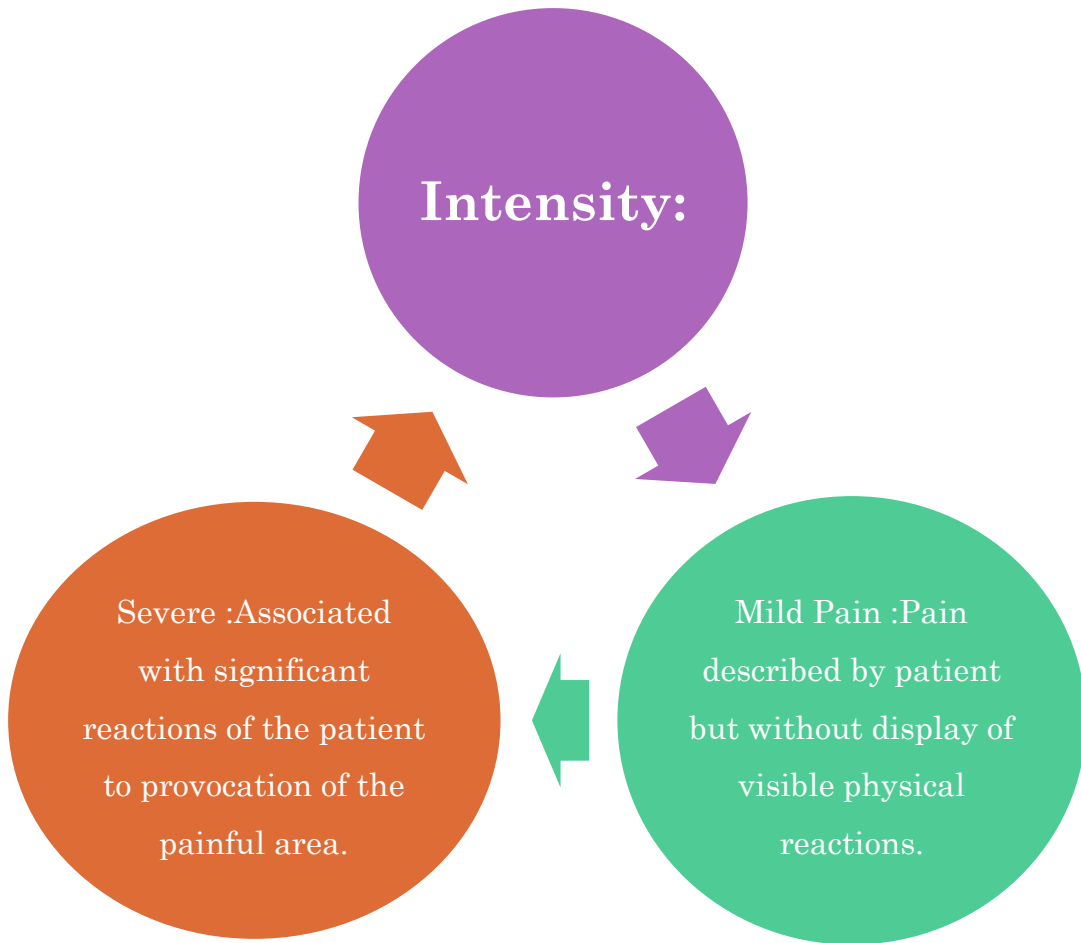


Duration

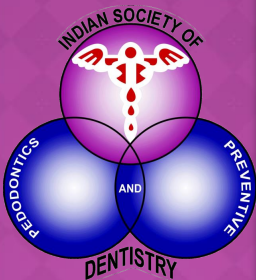


Location





Okeson JP. Pain mechanism. Bell's orofacial pains: the clinical management of orofacial pain. Chicago, Ill, USA: Quintessence Publishing Company; 2005.p 272-73



PROVOCATION & ATTENUATION

What produces or reduces symptoms?

Mastication

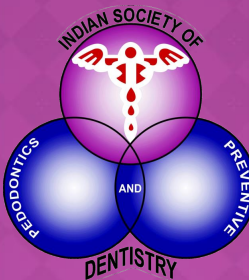
Drinking something cold

Non prescription pain relievers

Locally applied temperature

Chewing or biting

Narcotic medication



OBJECTIVE SYMPTOMS

- Visual and Tactile Inspection
- Percussion
- Palpation
- Mobility And Depressibility
- Bite Test
- Magnification
- Radiography
 - Intraoral periapical radiographs
 - Cone beam computed tomography (CBCT)



VISUAL & TACTILE INSPECTION



Lip lift technique

PALPATION

EXAMINE TISSUE CONSISTENCY



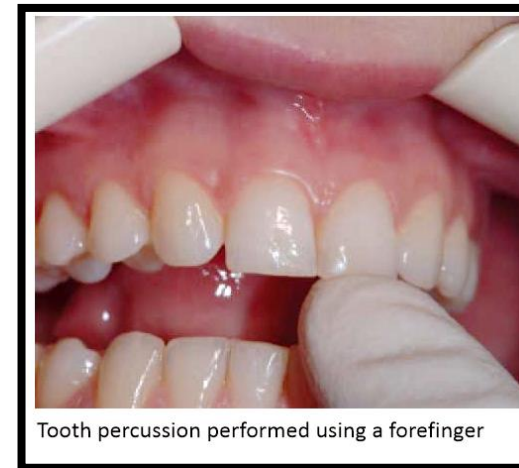
PERCUSSION TEST

Change the direction from vertical occlusal, buccal / lingual separate cusps

Sensitive response, differing from adjacent teeth



Symptomatic apical periodontitis.

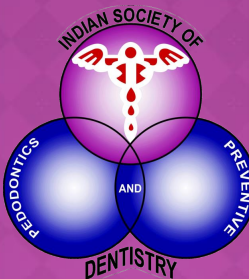


BY BELANGER

Percussion test cannot be performed with instruments used in Pediatric patients

- Children are more fearful and anxious,
- Root resorption

Courtesy: Dr.SonaliSaha



MOBILITY – DEPRESSIBILITY TESTING

USED TO EVALUATE THE INTEGRITY OF THE ATTACHMENT APPARATUS SURROUNDING THE TOOTH



MOBILITY



DEPRESSIBILITY



In primary teeth –
mobility is not
graded if it is
physiological,
graded if is
pathological

Greater the movement, poorer the prognosis.

ANAESTHETIC TEST

The suspected tooth should be anesthetized and, if the diagnosis is correct, the referred pain should disappear

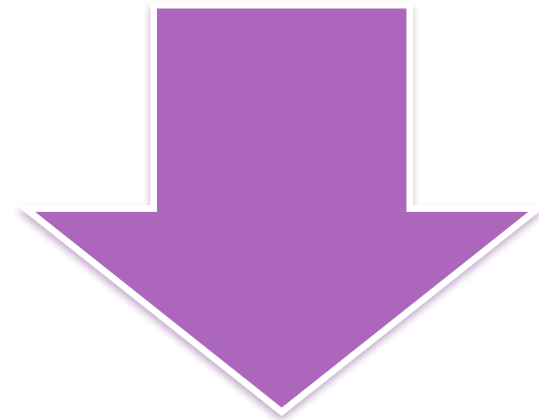


TEST CAVITY

If pulp is vital, the heat from bur will probably generate a response, no endodontic treatment



RADIOGRAPHS



CONVENTIONAL



“Road Map”

ADVANCED



ASSESSMENT OF PULP VITALITY

Neural sensibility tests

Thermal tests

Heat testing

Cold testing

Electric pulp tester (EPT)

Anesthetic test

Test cavity

Pulp vascularity tests

Laser Doppler Flowmetry

Pulse oximetry

Recent technologies

Dual-wavelength spectrophotometer

Thermography

Crown surface temperature

Transmitted light photoplethysmography

SENSITIVITY DENOTES THE ABILITY OF A TEST TO DETECT DISEASE IN PATIENTS WHO ACTUALLY HAVE THE DISEASE.

SPECIFICITY DENOTES ABILITY OF A TEST TO DETECT THE ABSENCE OF DISEASE

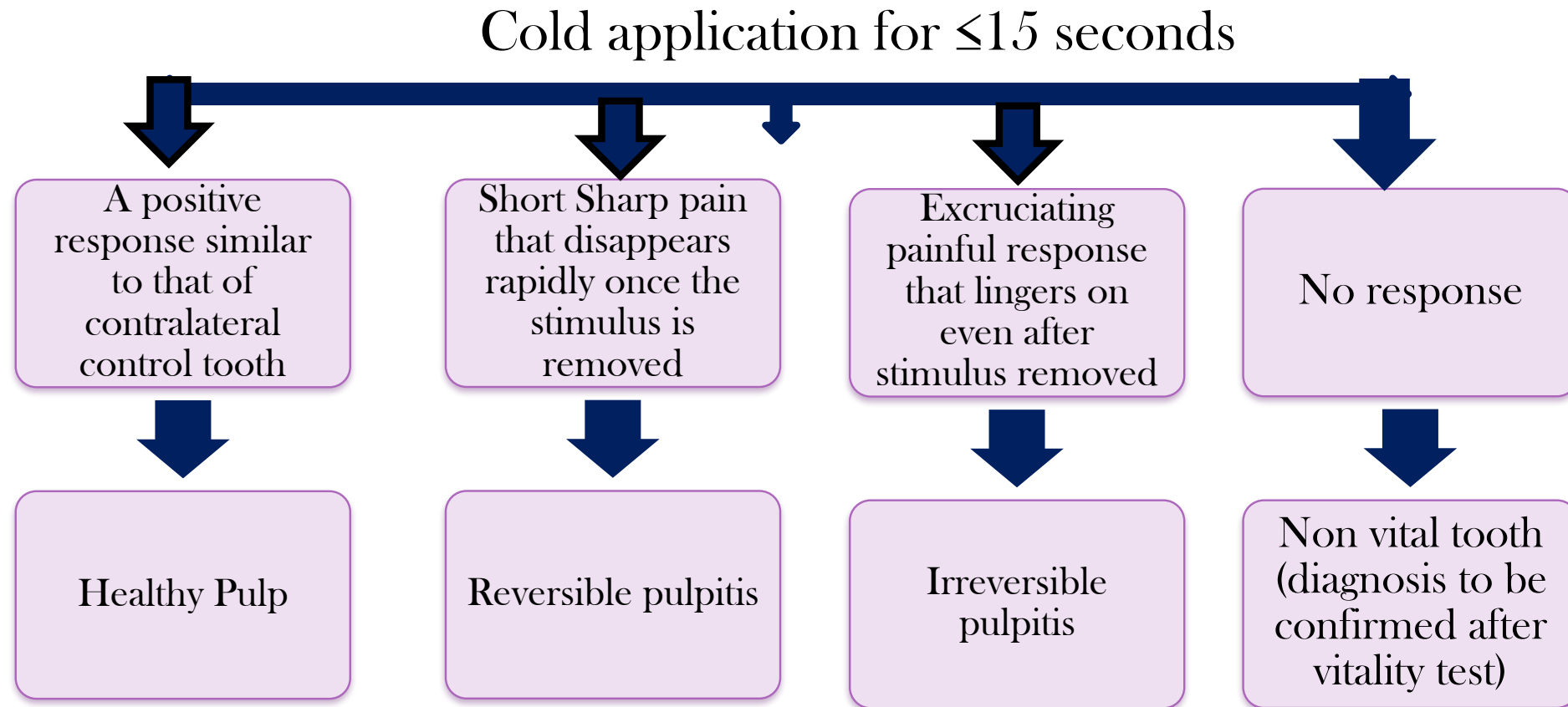
SENSITIVITY OF A PULPVITALITY INDICATES THE TESTS ABILITY TO IDENTIFY NON-VITAL TOOTH..

SPECIFICITY OF A PULPVITALITY INDICATES THE TESTS ABILITY TO IDENTIFY VITAL TOOTH..

Table 1. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for the cold test, electric test, and pulse oximeter test.

Test	Sensitivity	Specificity	PPV	NPV
Cold	0.81	0.92	0.92	0.81
Electrical	0.71	0.92	0.91	0.74
Pulse oximeter	1.00	0.95	0.95	1.00

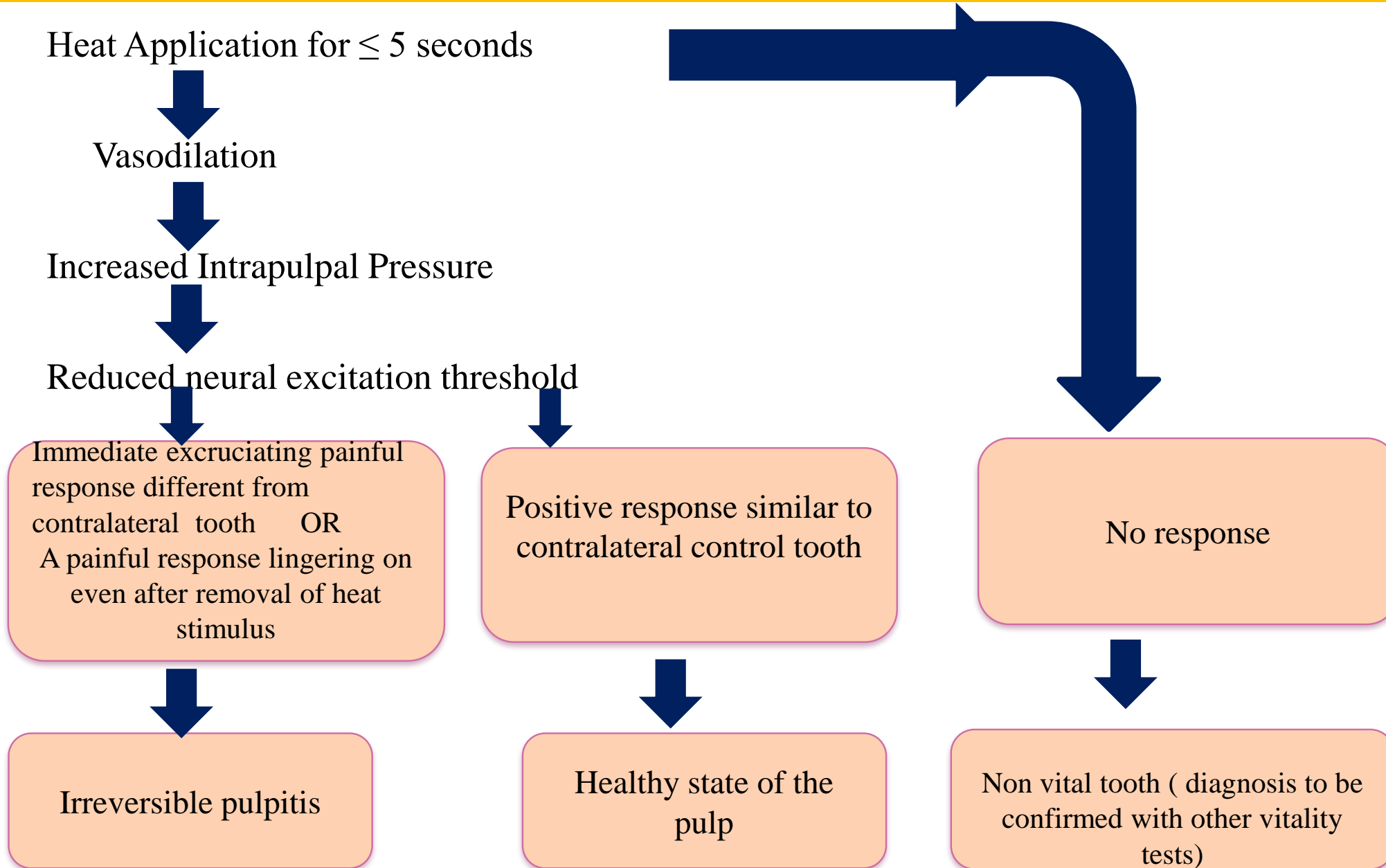
Mechanism of Cold Test (Brannstrom's Theory)



Cold test can be used to differentiate between reversible and irreversible pulpitis.

In irreversible pulpitis, patients complain of increased pain secondary to heat test, while in such a situation the gets relieved on application of cold

MECHANISM OF THE HEAT TEST (VAN HASSEL'S THEORY)

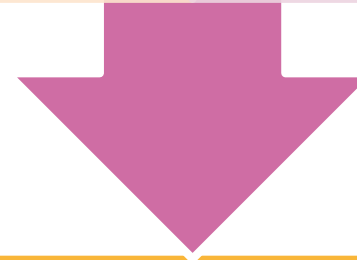


ELECTRIC PULP TEST (EPT)

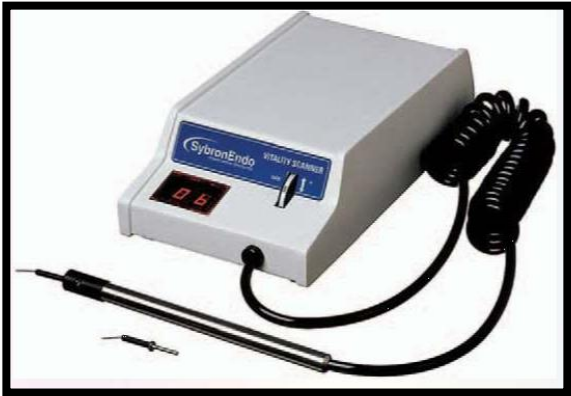
Objective is to stimulate a pulpal response by subjecting the tooth to an increasing degree of electric current.

EPTs assess integrity of A- δ fibres

C fibres do not respond to the EPTs (more current needed)



A positive response to EPT is due to ionic shift in dentinal fluid within DT inducing action potential with rapid hopping action at nodes in A- δ fibres





False positive response:

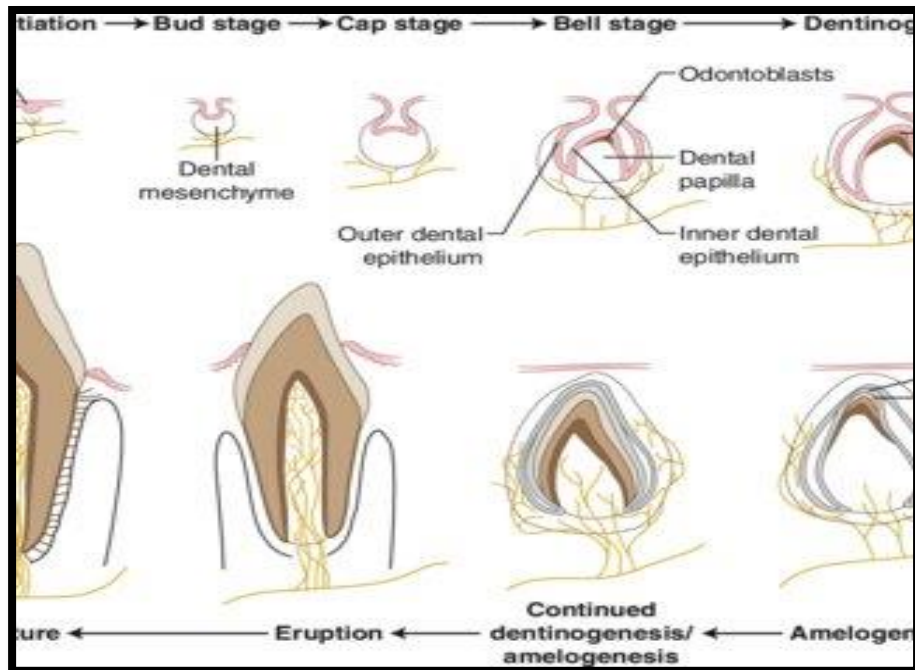
- Multirooted teeth in which the pulp is vital in one or more canals
- Failure to isolate/dry teeth properly
- Liquifaction necrosis
- Electrodes contact gingiva

False negative response:

- Teeth with extensive restorations / pulp protecting base
- Recently traumatized /newly erupted teeth with incomplete root formation
- Sedative medication
- High pain threshold

Question:

Electric pulp testing has shown to be unreliable in deciduous teeth and immature permanent teeth, WHY??



Answer:

- Immature permanent teeth are not fully innervated with A myelinated fibers as they form after root completion.
- Children adapt their behaviour to avoid a painful stimulus.
- Children more fearful and anxious.

LIMITATIONS OF PULP SENSIBILITY TESTS

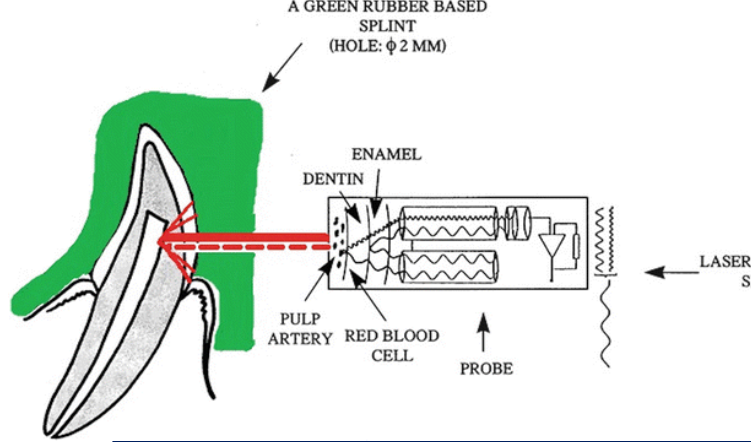
1. Subjective & measure only pulp nerve responses & not pulp blood flow.

(Gazelius et al. 1986, Schnettler & Wallace 1991).

2. Thermal tests require dentinal tubules to be open to allow fluid to flow according to the hydrodynamic theory.

3. Teeth with immature apices: A fibers not completely occur until final stages of root development *(Fulling & Andreasen 1976a, Fuss et al. 1986).*

4. The traumatized immature tooth with open apex –difficult to diagnose & treat : more subjectivity in young individuals. *(Tronstad 1988, Yanpiset et al. 2001).*



Currently, the only true vitality tests:

Laser Doppler Flowmetry (LDF)

Pulse Oximetry tests

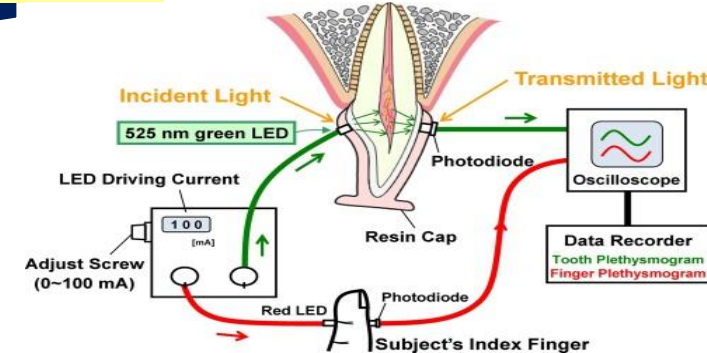
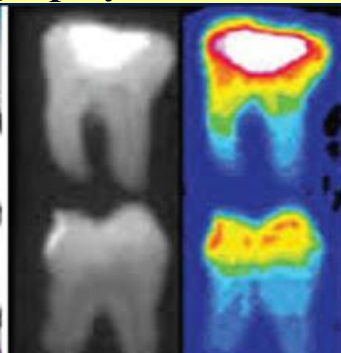
Dual WL Spectrophotometry

Plethysmography

Optical reflection Vitalometer

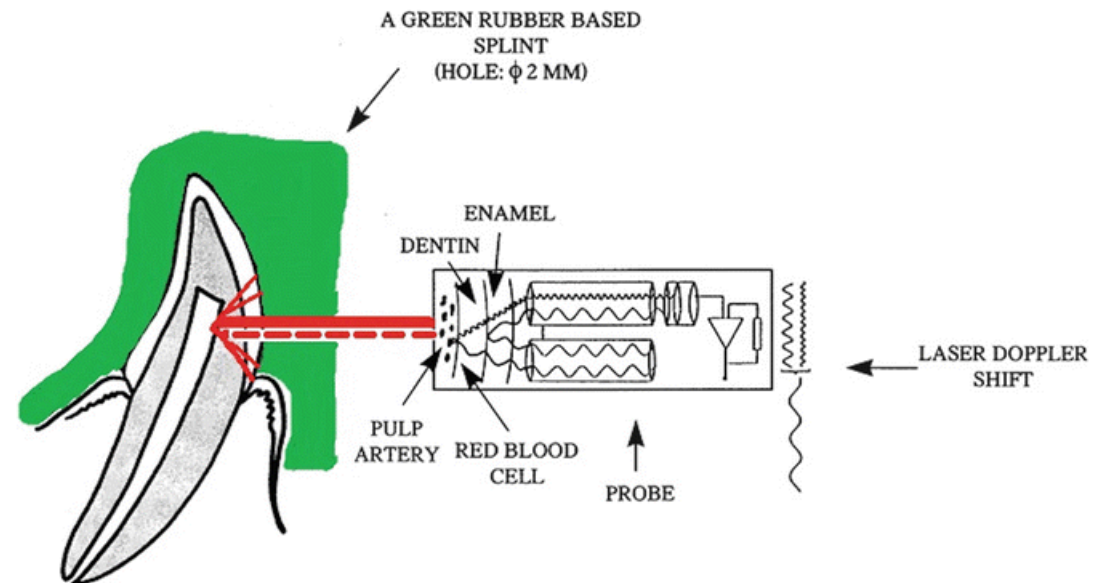
UV Fluorescence

Electronic Thermography



LASER DOPPLER FLOWMETRY

- Non invasive method to measure blood flow in tissues.
- Light enters the tooth and gets absorbed by the RBC which shift the scattered light.
- Emits infra red light beam from laser diode- deflected by moving RBC's.
- Technique Sensitive
- Expensive.



PULSE OXIMETRY

Direct measurement of pulp circulation-real measure of pulp vitality.

Pulp oximetry-completely objective **estimates blood oxygen saturation** levels by measuring & comparing amplitudes of the ratios of transmitted infra-red with red light.

The ratio varies with relative fractions of oxygen saturated to unsaturated Hb & is used to calculate oxygen saturation.

Capable of evaluating the blood vasculature status within a tooth & therefore pulp vitality.

Disadvantage – dependence on a pulsatile blood flow



Q: VALUE OF DENTAL HEMOGRAM

Introduced by Guthrie, 1959.

Drop of blood from an **exposed pulp** is used for making the hemogram. Based on histologic examination it is decided whether a tooth is good candidate for pulpotomy.

Those teeth in which the inflammatory process is localized to coronal pulp – Pulpotomy.

If inflammation is extended beyond the area of amputation- Pulpectomy.

Dental hemogram is **not a practical diagnostic method in clinical practice.**



***Correct diagnosis is not the end,
But the beginning of the practice!***

MOST COMMONLY ASKED QUESTIONS IN VIVA

- ◉ What is the blood flow of pulp?
- ◉ What is the oxygen carrying capacity of odontoblasts?
- ◉ Difference between neural sensibility and vitality tests?
- ◉ Why pulp gives only pain sensation to any stimulus?
- ◉ Why reversible pain is localised and irreversible pulpitis pain is diffuse?
- ◉ What is the diagnostic value of dental hemogram?
- ◉ How do you differentiate between pulp polyp and gingival polyp?
- ◉ Why is there accumulation of infection in furcation region of primary molars?
- ◉ Why abscess in primary teeth called as dentoalveolar abscess rather than periapical abscess?
- ◉ What is the difference between reversible and irreversible pulpitis?
- ◉ What is the amount of reparative dentin formation per day
- ◉ What are homeobox genes?
- ◉ What is the intrapulpal pressure in healthy tooth, reversible and irreversible pulpitis?
- ◉ What do you mean by compartment syndrome and its significance:
- ◉ Which diagnostic test is called as road map for endodontic treatment:
- ◉ Why it is called pulpectomy in primary teeth as compared to RCT in permanent teeth?
- ◉ What is phoenix abscess?

Hemodynamics of the Dental Pulp

S. CHEN

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REVIEW ARTICLE

Pulp Revascularization: A Literature Review

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Dental Pulp Hemogram

T. J. GUTHRIE,* RALPH E. McDONALD, and DAVI...

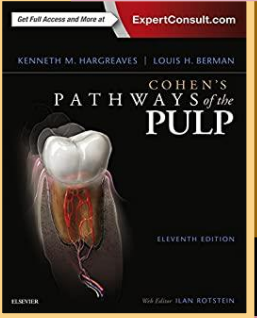
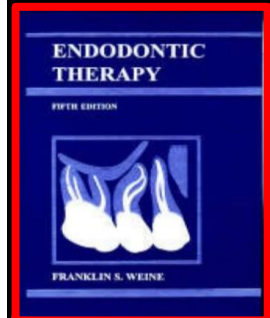
Indiana University School of Dentistry, Indianapolis, Indiana

ORIGINAL ARTICLE

Dentin comparison in primary and permanent molars under transmitted and polarised light microscopy: An *in vitro* study

Vascular reactions in the dental pulp during inflammation

Karin J. H. Tonder
University of Bergen, Institute of Physiology, Bergen, Norway

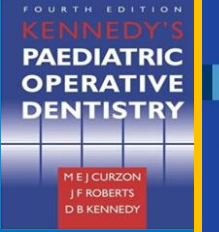


DOI: 10.1111/j.1365-265X.2008.00955.x

Assessment of pulp vitality: a review

VELAYUTHAM GOPIKRISHNA, GALI PRADEEP & NAGENDRABABU VENKATESHRAJU

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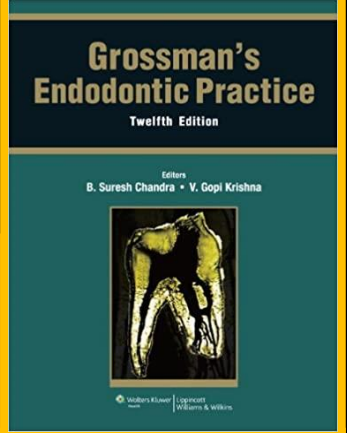
10.5005/jp-journals-10005-1073

REVIEW ARTICLE

Diagnostic Aids in Pediatric Dentistry

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Invited Author

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Reversible And Irreversible Painful Pulpitides: Diagnosis And Treatment

Review Article

Dental Pulp Testing: A Review

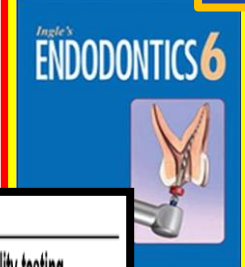
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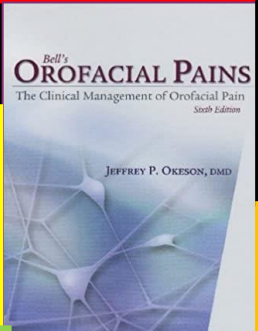
Received 23 May 2009; Accepted 28 September 2009

Recommended by Lucas W. M. van der Sluis



Pulp response to restorative materials

Helmut A. Zander,* D.D.S., Rochester, N. Y.



Recent advances in pulp vitality testing

*Sangeet R, *Indira R, *Shrinivas MR, *Kumar A

Conference Paper

Vital Pulp Therapy with New Materials for Primary Teeth: New Directions and Treatment Perspectives

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Concluding remarks

S. KIM

clinical section

Pulse oximetry evaluation of vitality in primary and immature permanent teeth

Clara Galois, DDS

Dr. Galois is a Col. in the United States Army Dental Corps, Wuerzburg Dental Activity in Germany

INVITED REVIEW ARTICLE

Odontoblasts: Specialized hard-tissue-forming cells in the dentin-pulp complex

Nobuyuki Kawashima, and Takashi Okiji
Department of Pulp Biology and Endodontics, Division of Oral Health Sciences, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University (TMDU), Tokyo, Japan

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/301231313>

International Journal of Clinical Pediatric Dentistry

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Pulp Therapy for the Primary Dentition

HETZKY, AND MARCIO GUELMANN

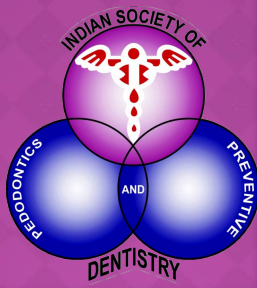
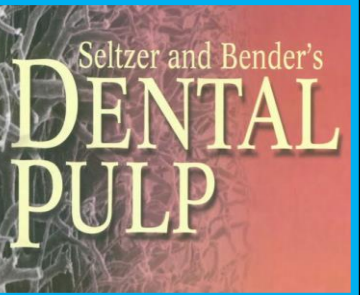
Review Article

Current trends and future perspectives of dental pulp capping materials: A systematic review

E. McDonald, D.D.S., M.S., Indianapolis

Diagnostic aids and vital pulp therapy in deciduous teeth

E. McDonald, D.D.S., M.S., Indianapolis





*Thank
You*

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